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ARCHIVES OF OTOLARYNGOLOGY

VOLUME 9 FEBRUARY, 1929 NUMBER 2

THE PHYSIOLOGY OF VESTIBULAR NYSTAGMUS*

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CHICAGO

Vestibular nystagmus is an intricate physiologic phenomenon. This is due to the incomplete knowledge of the subject but will still be true when the knowledge is complete, because of the complexity of the mechanisms involved.

The phenomenon has long attracted the interest of the physiologist because of the importance of the eyes and their compensatory movements and the relation of the eyes to the labyrinth. During the last two decades, it has increasingly attracted the attention of the clinician, because it is used extensively as an aid in neurologic and otologic diagnosis, and as a test of fitness in aviation.

It is my object in this paper to outline briefly, and as simply as possible, the present status of the knowledge of the physiology of vestibular nystagmus.

DEFINITION

Vestibular nystagmus is manifested by movements of the eyes (and also of the head in some animals) when the nonacoustic or vestibular labyrinth is stimulated; for example, if the head is rotated to the right, the eyes will be caused to move to the left at an equal rate so that they continue to look in the same direction and attempt to avoid the confusion of moving images on the retina. The eyes soon come to the limit of possible motion to the left, and then they are quickly moved back to the right to, or toward, the primary position of the eyes. Vestibular stimulation results in two different types or phases of eye movement: (1) a deviation of the eyes, or the slow component, or the reaction-phase (Ewald[1]) and (2) the quick return, or the quick component, or the nystagmus-phase (Ewald). It is common usage to speak of the direction of the quick return movement as the direction of the nystagmus. The

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* From the Department of Physiology and Pharmacology, Northwestern University Medical School.

* Read before the Section on Laryngology, Otology and Rhinology at the Seventy-Ninth Annual Session of the American Medical Association, Minneapolis, June 13, 1928.

1. Ewald, J. R.: Physiologische Untersuchungen über das Endorganes des Nervus Octavus, Wiesbaden, 1892.

plane of rotation determines the direction of the nystagmus, which may be horizontal (horizontal plane), rotary (frontal plane), vertical (sagittal plane) or a combination of any two. Favill [2] has obtained twenty-six forms of rotationally induced nystagmus. On rapid rotation only the deviation of the eyes occurs; the quick return movement does not occur because of inhibition. On cessation of rotation, an afternystagmus, or postrotory nystagmus occurs, which is opposite in direction to the rotary nystagmus.

CAUSE OF DEVIATION OF EYES ON VESTIBULAR STIMULATION

It is well established that stimulation of the sensory end-organs in the nonacoustic or vestibular labyrinth is the cause of the deviation of the eyes on rotation, changes in temperature and electrical excitation. But how rotation stimulates the end-organs (the cristae) is a moot question.

MECHANISM OF STIMULATION OF THE CRISTAE

It was found by the early experimenters that mechanical and electrical stimulation of the ampulla of a canal caused movements in the plane of the canal stimulated (Flourens,[3] Cyon,[4] Breuer [5]). Hogyes [6] believed that the stimulation of the crista was the result of variations in the pressure of the perilymph. Mach [7] and Breuer [5] assumed that the rotation of the head in the plane of a canal caused a current in the canal contrary to the direction of rotation, which caused the crista to be excited. The classic experiments of Ewald,[1] in which he tied a canal in the pigeon and then produced movements in the endolymph by exerting pressure on the "ampullar end" of the canal by means of a pneumatic syringe, proved definitely that stimulation of the crista causes eye movements in a definite plane, and that the mechanical reversal of the endolymph movement in any canal causes a reversal in the direction of the nystagmus. As a result of Ewald's observations, the idea of endolymph movement, or currents, as the cause of excitation of the cristae has been generally accepted and almost universally taught.

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2. Favill, John: The Twenty-Six Normally Possible Forms of Rotationally Induced Nystagmus, Arch. Neurol. & Psychiat. **19**:318 (Feb.) 1928; An Explanation of the Mechanism of Induced Rotary and Vertical Nystagmus, ibid. **13**:479 (April) 1925.

3. Flourens, P.: Recherches experimentales sur les proprietes et les fonctions du systeme nerveux dans les animaux vertebres, Paris, 1842.

4. Cyon, E.: Compt. rend. Acad. d. sc. **82**:856, 1876.

5. Breuer, J.: Arch. f. d. ges. Physiol. **44**:135, 1889; ibid. **70**:494, 1898; Sitzungsb. d. k. Akad. d. Wissensch. Math.-naturw. cl. **112**:315, 1903.

6. Hogyes, A.: Jahresb. ü. d. Fortschr. d. Anat. u. Physiol (Literature, 1880) **9**:123, 1881.

7. Mach, E.: Sitbungsb. d. k. Akad. d. Wissensch. Math.-naturw. cl. **68**:121, 1874; Grundlimen der Lehre von den Bewegungs-empfindungen, Leipzig, 1875.

A number of fundamental objections can be raised against the view of endolymph currents. Mach [7] gave up the view because on rotation, he could not observe movements in the fluid within a glass model of the semicircular canals. Later, Breuer [5] recognized that the hair cells are covered with a gelatinous material (the cupula) and do not project into the endolymph. The experiments of Ewald [1] and Loeb [8] show that section, ligation or plugging of the canals does not prevent the appearance of eye movements on rotation. More recently, Maier and Lion [9] have studied the movement of fluid in capillary glass tubes, and in the actual canals of the pigeon and codfish. They concluded that the endolymph, because of its inertia, tends to remain at rest, which causes the hair cells, or the cupula, to be bent in a direction opposite to the direction of rotation. This bending excites the hair cells which reflexly cause the eyes to deviate. According to their own observations, however, a post-rotatory nystagmus, which lasts twenty seconds, is caused by a stimulus which lasts only a fraction of a second. In order to explain this, they assumed that the bending of the hair cells causes chemical changes in them which persist for some time after the bending has ceased, as for example, a retinal after-image. Gray [10] has reported that the squirrel, which manifests vestibular nystagmus, has a semicircular canal about one-fifth in diameter of that of man (man, about 0.75 mm.). It is difficult to conceive of a sensory end-organ that would detect such a minute inertia effect. Even if endolymph movements did occur, such a fact would not constitute proof that they were adequate stimuli.

Maxwell [11] has performed a crucial experiment to determine whether endolymph movement occurred in the canals. In the dog-fish, the nystagmus excited by horizontal rotation is caused only by the ampulla of the horizontal canal. The right horizontal canal was disected out for most of its length, ligated and cut near its posterior entrance into the utriculus. It was then moved from the horizontal to the vertical plane and held in place by a pledget of cotton. It was found that horizontal rotation to the right provoked a normal response, whereas rotation of the animal about its longitudinal axis, or in the new plane of the canal, did not provoke a response. This experiment proves conclusively that in the dog-fish, and there is no reason to believe that it is different in this respect from other vertebratas, the stimulation of the crista is not due to endolymph currents.

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8. Loeb, J.: Ueber Geotropisinus Bei Tieren, Arch. f. d. ges. Physiol. **49**:175, 1891.

9. Maier, M., and Lion, H.: Arch. f. d. ges. Physiol. **187**:47, 1921.

10. Gray, A. A.: The Labyrinth of Animals, Including Mammals, Birds, Reptiles, and Amphibians, London, J. & A. Churchill, 1907, vol. 1; 1908, vol. 2.

11. Maxwell, S. S.; J. General Physiol. **2**:349, 1920; Labyrinth and Equilibrium, Philadelphia, J. B. Lippincott Company, 1923; Am. J. Physiol. **29**:367, 1912.

It is further pointed out by Maxwell [11] that tension on the membrane of the utriculus would be transmitted to the ampulla and especially to the side which bears the crista, it being possible that such tension would stimulate the crista. As the utriculus does not fill the vestibule, and since the upper portion of its membrane is fixed and its lower portion is not, inertia or rotational effects of the perilymph in the vestibule, or of the endolymph in the utriculus, would cause changes in the tension on the lower portion of the membrane of the utriculus. This theory is reasonable because a larger cavity, such as the utriculus and vestibule, would render possible inertia and rotational effects of greater magnitude than the semicircular canals (fig. 1). This theory can explain caloric nystagmus without postulating convection currents in the canals by

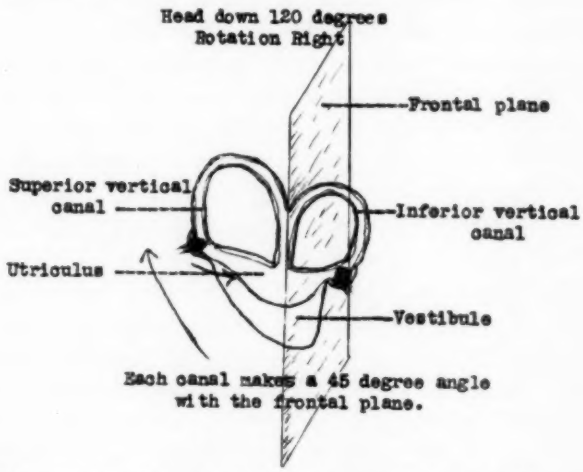


Fig. 1.—Diagram showing stimulation of crista of right superior vertical canal by inertia effect in perilymph and endolymph, according to Maxwell's theory.

making the reasonable assumption that changes in temperature would produce far greater changes in the larger mass of fluid in the vestibule than in the much smaller mass of fluid in the canals (fig. 2). This view is not inconsistent with the "pneumatic hammer" experiments of Ewald,[1] because fluid cannot be pushed from the canal without affecting the tension of the utricular membrane.

RELATION OF CANALS AND UTRICULUS TO MOVEMENTS OF THE EYES

Horizontal Canal.—It is generally agreed that stimulation of the ampulla of the right horizontal canal uniformly causes both eyes to deviate to the left, i.e., impulses are produced which reflexly cause the contraction of the left external rectus and the right internal rectus.

Maxwell [11] has shown that the remaining four muscles in each eye contract slightly, resulting in a steadying effect which produces a perfect movement. In other words, all the muscles of the eyes participate to form a definite muscle pattern, which results in the deviation of the eyes to the left. The right horizontal ampulla is excited chiefly, or possibly only, by turning to the right, and the left ampulla by turning to the left.

Vertical Canals.—There is no general agreement on the relation of the vertical canals to specific eye movements in man.

Direct stimulation of the ampulla of each vertical canal can be performed with accuracy in the dog-fish. In higher animals, one is forced to rely on the results of indirect stimulation.

In man, it is an established fact that with the head bent forward (120 degrees) while in the sitting posture, and then rotation performed, a rotary nystagmus occurs (the rotation is the frontal plane); and that

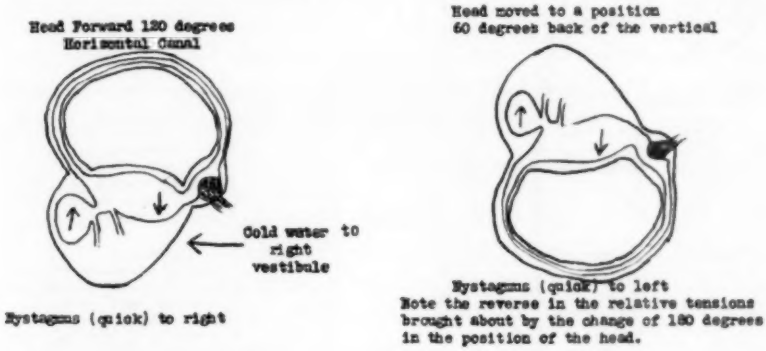

Head Forward 120 degrees
Horizontal Canal
Cold water to right vestibule
Nystagmus (quick) to right
Head moved to a position
60 degrees back of the vertical
Nystagmus (quick) to left
Note the reverse in the relative tensions
brought about by the change of 180 degrees
in the position of the head.

Fig. 2.—Explanatory diagram to show the principle of caloric stimulation, according to Maxwell's theory.

with the head bent toward the shoulder (90 degrees) while in the sitting posture, and then rotation performed, a vertical nystagmus results.

A number of explanations of this observation have been offered (Hogyes,[6] Ruttin,[12] Lemere,[13] Braun and Friesner,[14] Bard,[15] Jones,[16] Favill [2]), but a proved explanation is not available. Some investigators assigned different muscle pairs to the different ampullae; some assumed that different parts of the same crista innervate different muscles; others,

12. Ruttin, E.: Diseases of the Labyrinth, New York, Rebman Company, 1914.

13. Lemere, H. B.: Oculomotor Reaction to Labyrinth Stimulation, J. A. M. A. **71**:901 (Sept. 14) 1918.

14. Braun, and Friesner, I.: The Labyrinth, New York, Rebman Company, 1913.

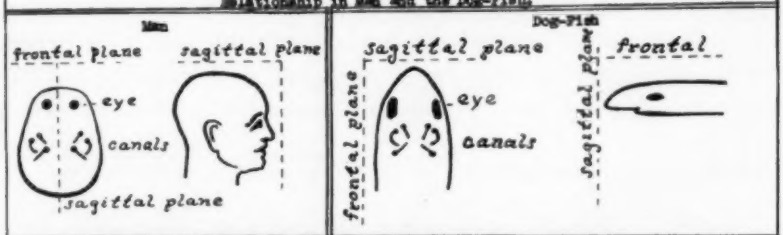
15. Bard, L.: Ann. de méd. **6**:175, 1919.

16. Jones, I. H.: Equilibrium and Vertigo, Philadelphia, J. B. Lippincott Company, 1918.

by assuming canal currents, explained vertical and rotary nystagmus by the combined or resultant effect of stimulation of the two right or left vertical ampullae.

Keeping in mind the following facts, it is possible to correlate vestibular nystagmus in the dog-fish and in man: 1. The compensatory movements of the eyes on rotation have a remarkably constant biologic characteristic, irrespective of species, namely, to attempt to maintain the field of vision present at the beginning of rotation. 2. The eyes of man,

Table 1.—A Correlation of the Eye and Semicircular Canal Relationship in Man and the Dog-Fish.



Visual plane of rotation	Body axis of rotation	Type of nystagmus	Visual plane of rotation	Body axis of rotation	Type of nystagmus
Sagittal	Transverse	Vertical*	Sagittal	Longitudinal	Vertical: Type of nystagmus caused by simultaneous stimulation of both vertical ampullae on one side.
Frontal	Dorso-ventral	Rotary†	Frontal	Transverse	Rotary: Type of nystagmus caused by stimulation of one vertical ampulla or by simultaneous stim. of either both anterior, or both posterior ampullae.
Horizontal	Longitudinal	Horizontal	Horizontal	Dorso-ventral	Horizontal: Caused by stimulation of one horizontal ampulla.

Comparison of man and dog-fish: Eyes have moved anteriorly and rotated medially 90 degrees; and the canals have rotated anteriorly 90 degrees, which has kept constant the horizontal canal-external-internal rectus relationship; and the ampulla of the posterior vertical canal of the dog-fish has moved to the center through an arc of about 180 degrees.
*Elicited in man by bending head to right shoulder (ninety degrees) and rotating.
†Elicited in man by bending head forward 120 degrees and rotating.

as compared with those of the dog-fish, have moved anteriorly and rotated inward 90 degrees. 3. The canals of the dog-fish have rotated upward (anteriorly) 90 degrees, which, along with the 90 degrees rotation of the eyes, has kept the horizontal canal-internal-external rectus relationship the same in both dog-fish and man. 4. The frontal plane of the dog-fish is parallel to the sagittal plane of man. It should be pointed out, also, that the ampulla of the posterior canal has a medial position in man, whereas in the dog-fish it has a more external position. The correlation is shown in table 1. It is seen that rotation in identical visual planes results in the same type of nystagmus in man and in dog-fish.

Because of this correlation between the visual plane of rotation and the type of nystagmus that results in man and in dog-fish, it is reasonable to carry the correlation further and to assume that the same type of stimulation of the vertical canals occurs in man. In the dog-fish, stimulation of one vertical canal, mechanically, causes a rotary nystagmus; stimulation of both vertical canals causes a vertical nystagmus. It is not improbable, then, that the rotation of man in the frontal plane stimulates only one vertical ampulla, the anterior; and that rotation in the sagittal plane stimulates both vertical ampullae.

It is possible for such a stimulation to occur on the basis of Maxwell's theory of tension exerted on the crista, or cristae, from changes in the position of the utricular membrane due to inertia changes in the perilymph in the vestibule (fig. 1).

Using the foregoing fact of a correlation between the visual plane and the type of nystagmus, I have selected the various eye muscles in man chiefly influenced by the various ampullae, considering the fact that the function of the obliques and the superior and inferior recti muscles and the position of the ampulla of the posterior canal have changed during the course of evolution.

Tables 2 and 3 show the changes that have occurred. The inferior and superior obliques changed either ampullae, or central connections, because they were antagonistic to the superior and inferior recti, respectively, in the dog-fish, but are protagonistic in man. The superior recti changed ampullae, or central connections, because in the dog-fish they pull the eye up and out, whereas in man they pull the eye up and in. The inferior recti changed ampullae, or central connections, because in the dog-fish they pull the eye down and out, and in man they pull the eye down and in.

PATHWAY OF IMPULSES

It is not the province of this paper to discuss the literature on the pathway of impulses from the vestibular apparatus to the motor nuclei of the muscles of the eye (Mukens [17]).

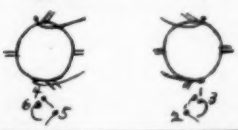
Some investigators have thought that the effects of the labyrinth are produced through the cerebellum (Luciani [18]). It is true that anterior cerebellar lesions cause spontaneous nystagmus, in my experience "ataxic" in type, and that after the spontaneous nystagmus disappears, the response to rotation is increased for months. But it is now well established that labyrinth effects, including rotation nystagmus, occur normally in the absence of the cerebellum, and that destruction of the

17. Muskens, L. J. J.: Nederl. Tijdschr. v. Geneesk. **58**:970, 1914; Brain **36**: parts 3 and 4, 1914.

18. Luciani, L.: Ergebn. d. Physiol. **3**:318, 1904.

Table 2.- Movements of the Eyes in the Dog-Fish.
(considering only muscles chiefly concerned)

Stimulation of Ampulla	Muscles	Deviation of Eyes L.	Deviation of Eyes R.
1.	R. sup. rect. R. inf. obl. L. inf. rect. L. inf. obl.	down and back	up and back
		rotary	
2.	R. sup. rect. R. sup. obl. L. inf. rect. L. sup. obl.	down and front	up and front
		rotary	
1. & 2.	R. sup. rect. R. sup. obl. L. inf. rect. L. inf. obl.	down	up
		vertical	
3.	R. int. rect. L. ext. rect.		
		horizontal	
4.	R. inf. rect. R. inf. obl. L. sup. rect. L. inf. obl.	up and back	down and back
1. & 4.	R. inf. obl. L. inf. obl.	both eyes roll back	
1. & 3. 2. & 4.	nothing	nothing	

Man, if muscles acted as in dog-fish			Man, as muscles actually work		
L.	R.		L.	R.	
					
6 5	2 3		6 5	2 3	
Stimulation of Ampulla	Muscles	Deviation of Eyes L. R.	Stimulation of Ampulla	Muscles	Deviation of Eyes L. R.
1.	R. sup. rect. R. inf. obl. L. inf. rect. L. inf. obl.	does not occur	1.	R. sup. rect. R. sup. obl. L. inf. rect. L. inf. obl.	down&in up&in up&out down&out left rotary deviation
2.	R. sup. rect. R. sup. obl. L. inf. rect. L. sup. obl.	does not occur	2.	R. inf. rect. R. inf. obl. L. sup. rect. L. sup. obl.	up&in up&out down&out down&in right rotary deviation
1. & 2.	R. sup. rect. R. sup. obl. L. inf. rect. L. inf. obl.	should be vertical?	1. & 2.	R. inf. rect. R. sup. obl. L. inf. rect. L. sup. obl.	vertical rotation backward
3.	R. int. rect. L. ext. rect.	horizontal	3.	R. int. rect. L. ext. rect.	horizontal
4.	R. inf. rect. R. inf. obl. L. sup. rect. L. inf. obl.		4.	R. inf. rect. R. inf. obl. L. sup. rect. L. sup. obl.	up&in down&in down&out up&out
1. & 4.	R. sup. rect.? R. inf. obl. L. sup. rect.? L. inf. obl.		1. & 4.	R. inf. rect. R. sup. obl. L. inf. rect. L. sup. obl.	vertical down
1. & 3. 2. & 4.	nothing		1. & 3. 2. & 4.	same as 1 same as 2	

According to Fuchs(38) upward movement is due to superior rectus and inferior oblique.
" " " downward movement " " " inferior " " superior " .
According to Barany(40) inward rotation is due to the superior rectus and oblique.
" " " outward rotation " " " " inferior " " " .

labyrinth does not prevent the typical effects of cerebellar injuries (Lange,[19] Beyer and Lewandowsky,[20] Wilson and Pike,[21] de Kleijn and Magnus [22]). I have confirmed this fact (Selling and Kistner [23]).

THE QUICK COMPONENT—THE NYSTAGMUS PHASE

Although it is well established that the deviation of the eyes is caused by the labyrinth, I am not so certain as to the cause of the quick return movement. It has been commonly said to be due to a cortical or cerebral reflex. This, however, is certainly incorrect. Ewald [1] found that

Table 3.—Showing the Change of Eye Muscles, or Central Connections, of the Vertical Ampullae from Dog-Fish to Man, according to the Presumed Changes shown in Table 2.

Out of Anterior Ampulla	Into Anterior Ampulla
Right inferior oblique	Right superior oblique
Out of Posterior Ampulla	**Into Posterior Ampulla**
Right superior rectus Right superior oblique Left inferior rectus	Right inferior rectus Right inferior oblique Left superior rectus

The superior and inferior obliques probably changed ampulla, or central connections, because they are antagonistic to the inferior and superior recti, respectively, in the dog-fish, but are partly protagonistic to these muscles in man.
The superior recti probably changed ampullae, because in the dog-fish they pull the eye up and out, but in man, they pull the eye up and in.
The inferior recti probably changed ampullae, because in the dog-fish they pull the eye down and out, but in man they pull the eye down and in.

pigeons show nystagmus after extirpation of the cerebral hemispheres. Bauer and Leidler [24] Magnus [25] and I [26] have found that nystagmus

19. Lange, B.: Arch. f. d. ges. Physiol. **50**:615, 1891.
20. Beyer, H., and Lewandowsky, M.: Arch. f. Physiol., 1906, p. 45.
21. Wilson, J. G., and Pike, F. H.: Phil. Tr. **203**:127, 1912; The Mechanism of Labyrinthine Nystagmus and Its Modifications by Lesions in the Cerebellum and Cerebrum, Arch. Int. Med. **15**:31 (Jan.) 1915.
22. de Kleijn, A., and Magnus, R.: Arch. f. d. ges. Physiol. **180**:291, 1920; J. Physiol. **15**:311, 1894.
23. Selling, Laurence, and Kistner, F. B.: The Labyrinthine Tests in Cerebellar Diagnosis, J. A. M. A. **81**:1194 (Oct. 6) 1923.
24. Bauer, J., and Leidler, R.: Arch. Neurol. Inst. **19**:155, 1911.
25. Magnus, R., Arch. f. d. ges. Physiol. **163**:405, 1916.
26. Ivy, A. C.: J. Comp. Neurol. **31**:1, 1919.

(slow and quick component) also occurs in mammals after the removal of the cerebrum. My investigations have shown that hemidecrebration in the rabbit, cat and dog causes an increase in vestibular nystagmus when the slow component is directed opposite to the side of the lesion. When the slow component is directed to the side of the lesion, nystagmus occurs, although sometimes it is diminished. The general conclusion which is warranted by my observations is that the quick component of vestibular nystagmus is not due to the integrity of a cerebral reflex arc, but is dependent on some center below the thalamus, over which the cerebrum exercises its well recognized inhibitory influence.

Tozer and Sherrington[27] demonstrated the presence of sensory tendon nerves in the extrinsic muscles of the eyes, which pass to the midbrain via the third, fourth and sixth cranial nerves. The deviation of the eye caused by stimulation of the labyrinth puts the muscles of the eyes under tension and stimulates their sensory endings. These impulses acting via the muscle centers of the eyes cause the deviated eyes to be quickly jerked back to the primary position. In other words, the quick return of the eyes, or the nystagmus, is due to stimulation by tension of sensory endings in the tendons of the muscles of the eyes, which excites a reflex through the third, fourth and sixth cranial nuclei that results in the contraction of the particular muscles of the eyes the contraction of which would bring the eyes back to the primary position.

Another possibility as to the cause of the quick return movement has been suggested by de Kleijn,[28] namely, that the cranial nuclei, or some center, exert a tonic influence over the muscles of the eyes to produce a muscle pattern which constantly tends to keep the eyes in the primary position. He sectioned the brain just anterior to the anterior corpora quadrigemina and cut both third and fourth nerves, and the right sixth nerve. Caloric stimulation of the ear caused characteristic contractions of the left rectus muscle, including the quick contractions which cause the return movement. He then injected procaine hydrochloride (1 per cent) and found that both movements, the deviation and the quick return, disappeared simultaneously. This result strongly suggests that the origin of both sets of impulses is central. It may be, however, that in the case of the muscles of the eyes the threshold to procaine hydrochloride is the same for the sensory impulses from the muscles of the eyes and for the motor impulses to the muscles of the eyes; this, however, is not likely.

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27. Tozer, F. M., and Sherrington, C. S.: Proc. Roy. Soc. London **82**:450, 1910.

28. De Kleijn, A.: Versl. d. wis-en naturk. Afd. d. k. Akad. v. Wetensch. **29**:1230, 1921.

It has been generally accepted that the muscles of the eyes are reciprocally innervated, that is, when a muscle of the eye contracts, its antagonist relaxes. This has been demonstrated by the experiments of Maxwell,[29] Bartels [30] and by Kleitman and de Kleijn.[31] Recently, this has been questioned by Tilney and Pike,[32] and by Lorente de No.[33] More recently, however, Huddleston and De Feo [34] have confirmed the originally accepted view that the muscles of the eyes conform to the principle of reciprocal innervation.

SUMMARY

On stimulation of the nonacoustic labyrinth, movements of the eyes occur which are compensatory in nature. The movement of the eye is characterized by a slow movement called the deviation, or slow component, and a quick movement opposite in direction to the deviation called the nystagmus, or quick component. The deviation of the eyes is due entirely to stimulation of the labyrinth. The nystagmus is most probably due to a reflex via the muscle centers of the eyes which is excited by the stimulation of kinesthetic sensory nerve endings in the muscles of the eyes, and is not due to a cerebral reflex arc. The cerebrum exercises its well known inhibitory control over this reflex. It is pointed out that the cristae of the canals are most probably not stimulated by the inertia effect of canal currents, and that Maxwell's theory, which holds that the cristae of the ampullae are stimulated by changes in tension of the utricular membrane caused by inertia effects in the larger bodies of fluid in the vestibule and utriculus, is more reasonable and probable. It is shown that a correlation exists between the type of nystagmus that results from rotation in the various visual planes in the dog-fish and in man.

ABSTRACT OF DISCUSSION

DR. EUGENE R. LEWIS, Los Angeles: In 1921 and 1922, I made an extensive study of the question as to whether a tube the size of the canal of the labyrinth would or would not show fluid movements according to fluid inertia, and I convinced myself that, once surface tension is eliminated, fluid in a capillary tube

29: Maxwell, S. S., and Huddeston, O. A.: J. General Physiol. **8**:441, 1926; (footnote 11).

30. Bartels, M.: Arch. Ophth. **173**:129, 1911.

31. Kleitman, N., and de Kleijn, A.: Am. J. Physiol. **69**:160, 1924.

32. Tilney, F., and Pike, F. H.: Muscular Coordination Experimentally Studied in Its Relation to the Cerebellum, Arch. Neurol. & Psychiat. **13**:289 (March) 1925.

33. Lorente de No, R.: Tr. Lab. recherches biol. universidad Madrid **23**:259, 1925.

34. Huddleston, O. L., and De Feo, H. E.: Proc. Soc. Exper. Biol. & Med. **25**:435, 1928.

behaves with regard to inertia as does fluid in a larger tube. I have had the privilege of seeing some of Maxwell's work, but I cannot believe that we must resign certain things which seem to have been pretty well demonstrated with respect to the semicircular canals simply because Dr. Maxwell has shed some additional light on the macular mechanism. His studies of the physiology of the macula will add greatly to the knowledge of the physiology of this complicated mechanism.

Dr. A. C. Ivy, Chicago: I did not have time to discuss completely the question of canal currents. I do not deny, and so far as I know no one denies, the possibility of canal currents in the semicircular canals; but, granted that they do occur, that does not prove that they stimulate the cristae. Loeb, Ewald and others have tied the semicircular canal so currents could not occur (minute inertia effects could occur, but not canal currents) and they got the same effect on rotation with the canal tied as without. That in itself is sufficient evidence to show that canal currents are at least not the only stimuli for the cristae. Maxwell's experiments on the dog-fish prove conclusively that canal currents are not concerned, but that the most probable source of the stimulus is tension on the crista of the semicircular canal caused by changes in the position of the utricular membrane.

Another point is that the labyrinth may be termed a kinesthetic end-organ, and kinesthetic end-organs are stimulated by pressure and tension. Maxwell's theory holds that it is pressure and tension that stimulate the cristae.

THE MODIFIED RADICAL OPERATION ON THE MASTOID*

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A modified radical operation on the mastoid was devised with the idea of removing the diseased bone in selected cases of chronic suppurative otitis media and conserving or improving the hearing by leaving undisturbed the membrana tympani and the ossicles.

Early in the nineties, soon after the introduction of the radical operation, Panse, Scheibe and Jansen were the first who made any attempt to preserve the ossicles. In 1897, Stacke recommended their preservation, and later Siebenmann several times made the same recommendation. Stacke's first case was reported in 1895, and the observations were published in 1897; in 1911, he [1] wrote of his method of operation, giving the indications and technic. In 1909, Bondy [2] reported having performed the operation on a number of patients and enumerated his ideas of the indications and his operative steps. In 1912, Bárány [3] published a report on "Conservative Radical Operation for Chronic Otitis Media." In 1912, Citelli [4] related his experience with the operation and expressed his opinion of its worth.

In England in 1904, Heath [5] reported the cases of ten patients operated on by his method. In this country in 1907, Bryant [6] published a paper entitled "The Radical Mastoid Operation Modified to Allow the Preservation of Normal Hearing." In 1911, Richards [7] discussed

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1. Stacke: Ueber Konservative Radikaloperation, Verhandl. d. deutsch. otol. Gesellsch. **20**:343, 1911.

2. Bondy, G.: Radikaloperation mit Erhaltung von Trommelfell und Gehörknöchelchen, Verhandl. d. Gesellsch. deutsch. Naturf. u. Aerzte, 1909, p. 246.

3. Bárány, R.: Meine methode der conservativen Radikaloperation bei chronischer Mittelohr-Eiterung, Med. Klin. **18**:726 (May 5) 1912.

4. Citelli: Sur l'operation radicale dite conservatrice, Arch. internat. de laryngol. otol. rhinol. **33**:362, 1912.

5. Heath, C. J.: Treatment of Chronic Suppuration of the Middle Ear without Removal of the Drum Membrane and Ossicles, Lancet **2**:1767 (Dec. 24) 1904.

6. Bryant, W. S.: The Radical Mastoid Operation Modified to Allow the Preservation of Normal Hearing, Tr. Am. Otol. Soc. **9**:292, 1905; ibid. **10**:349, 1907.

7. Richards, G. L.: The So-Called Conservative Radical Mastoid Operation with a Description of the Technique of Heath, Bondy and Siebenmann, Tr. Am. Laryngol. Rhinol. Otol. Soc. **20**:162, 1911.

the merits of some of the modifications of the radical operation. In 1915, Blackwell [8] made some contributions to the subject.

In the more recent literature, I found an article by Simpson,[9] in 1920, another on the subject by Blackwell,[10] in 1923, two communications by Page [11] in 1924, and one by Beck [12] in 1925, while in 1926, Fraser [13] refers at length to this operation. Beyer [14] read a paper on it before the Berlin Oto-Laryngological Society in 1925. The latest authors of textbooks give only brief space to it; Kerrison [15] gives the best outline, Loeb [16] a condensed statement, while Kopetzky [17] alludes to the procedure, only to condemn it.

As it appears that there is a distinct place in aural surgery for this operation and a paucity of information about its details available to those who could use it, it seems desirable, without a painstaking and time-consuming study of the literature, to collate the premises on which the operation is based by the various authors of the most important modifications, the differences of technic and the results.

ESSENTIALS OF THE OPERATION

All authorities agree on certain fundamentals: exenteration of the mastoid cells, wide exposure of the antrum and the zygomatic region, a lowering of the posterior bony wall of the canal to within from one-eighth to one-fourth inch of the epitympanic bony ring, exposure

8. Blackwell, H. B.: Exposure and Curettement of the Attic, Tr. Am. Otol. Soc. **13**:538, 1913-1915; Modified Radical Operation Based on 13 Cases, New York M. J. **104**:402 (Aug. 26) 1916.

9. Simpson, W. L.: The Operative Treatment of Chronic Suppurative Otitis Media, South. M. J. **14**:574, 1921.

10. Blackwell, H. B.: A Modified Radical Operation for Chronic Suppurative Otitis Media, Presentation of Patients Showing Results, Laryngoscope **34**:210 (March) 1924.

11. Page, J. R.: The Operative Treatment of Chronic Otorrhea, Tr. Am. Otol. Soc. **16**:618, 1922-1924; Some Remarks on the Technique of the Modified Radical Mastoid Operation, Laryngoscope **35**:268, 1925.

12. Beck, Karl: Zur Frage der partiellen Radikaloperation des Ohres, Ztschr. f. Laryngol., Rhinol. **13**:411, 1924-1925.

13. Fraser, J. S.: Results of the Radical and Modified Radical Operations for Mastoiditis, Brit. M. J. **2**:1154 (Dec. 18) 1926.

14. Beyer: Zur Technik der konservativen Radikal-Operation, Internat. Centralbl. f. Ohrenh. **26**:118, 1926; Zwei Fälle von konservativ operiertem Cholesteatom, discussion of papers by Bruhl, Claus, Schötz, von Eiken and Passow, ibid. Centralbl. f. Ohrenh. **26**:206, 1926.

15. Kerrison, P. D.: Diseases of the Ear, ed. 3, Philadelphia, J. B. Lippincott Company, 1923, pp. 455-457.

16. Loeb, H. W.: Operative Surgery of the Nose, Throat and Ear, St. Louis, C. V. Mosby Company, 1917, pp. 357-359.

17. Kopetzky, S. J.: Otologic Surgery, New York, Paul B. Hoeber, 1925, pp. 187-189.

of the attic by removal of a variable amount of its external wall, a plastic flap and drainage through the external auditory canal, with closure of the posterior wound.

INDICATIONS FOR OPERATION

A complete radical operation, generally speaking, does not affect the function of hearing favorably. In Ruttin's article on the functional results, he gave his conclusions as follows: The hearing in patients with a capacity for hearing for conversational speech of from 1.5 to 2 meters before operation, was not, as a rule, further impaired. He divided 100 of his patients into two groups; those with a hearing capacity of 2 meters or under for ordinary speech, and those hearing better. In the latter group, there were forty; in eight, hearing was improved after operation; in six, it was unchanged, while in twenty-six it was further impaired, in some markedly. On analyzing these twenty-six cases in which the patients showed further deterioration, he noted that ten of them had had a preserved tympanic cavity and a small perforation. These ten patients showed a marked loss in hearing, and two of them with a perforation in Shrapnell's membrane and an intact tympanic cavity showed a diminution in hearing at a distance of from 7 to 0.5 meter for ordinary speech. In the fourteen cases in which the patients did not show further loss in hearing after operation, there were gross defects in the tympanum, with partial or total loss of the ossicles.

Stacke [1] says that indications for this operation are present in three groups in which there are characteristic pathologic conditions in the attic, aditus and antrum, generally cholesteatomatous. These conditions are: (*1*) fistula lying high up in Shrapnell's membrane in front of, above or behind the short process of the malleus, or greater or less destruction of the lateral wall of the attic; (*2*) pathologic separation of the drum membrane behind and above, with secondary adhesion of the border and attachment to the surface of the wall of the labyrinth or to the wall of the aditus, underneath the prominence of the facial nerve, and (*3*) more seldom, perforation of the floor of the antrum at the side of the aditus into the posterosuperior bony portion of the external auditory canal. He says that almost without exception that one finds in these groups complete closure of the tympanum. The air douche through the catheter does not cause perforation noises; such a tympanum does not suppurate and perhaps has never suppurated.

In all his cases he endeavors to preserve the tympanic cavity in as nearly a normal state as possible, and to keep it entirely closed toward the external auditory canal. He has not used this operation in cases of chronic perforation of the pars tensa, because he considers it less promising in these cases and usually contraindicated.

Bondy's [2] indications for the modified radical operation include cases in which ordinary speech is heard at a distance of more than 2 meters, in which the continuity of the chain of ossicles is established and in which appreciable changes in the tympanic cavity are absent; in other words, especially cases in which Shrapnell's membrane is perforated but the tympanum is intact and hearing is good. He thinks that when the patient can hear at a distance of less than 2 meters, operation should not be considered.

Bárány [3] says that his method is indicated whenever an occlusion of the tube is demonstrable before the operation. If the tympanic membrane is preserved in its entire length, if the perforation is located in the attic and if the connection of the incus with the stapes is intact, then the tympanic membrane, malleus and the incus should be preserved.

Citelli [4] thinks that from the surgical and vital points of view, the complete radical operation is always preferable to the modified radical operation. He thinks, however, that the modified operation is indicated when one hesitates between the radical operation and a simple mastoidectomy, and that it can also be employed when evident manifestations of caries of the labyrinthine wall of the tympanum are not present, when a lesion of the tegmen tympani is not suspected or when there is a certain mobility of the ossicles; or, if the question of hearing comes up, when the opposite ear hears almost nothing, or when the patient must constantly use the affected ear. He has devised a slight modification in the performance of the complete radical operation wherein, after removing the incus and malleus delicately, taking care not to disturb the stapes, he avoids cureting the labyrinthine wall of the tympanum, the aditus and the region of the round window; this makes the labyrinth more safe from propagation of infection, conserves hearing and lessens the danger to the facial nerve.

Blackwell,[10] who has performed a large number of modified radical operations with excellent results, thinks that such an operation is indicated in any case of chronic purulent otitis media in which the patient has good hearing; he considers the outlook more favorable when the patient has a wide antrum. He believes that the modified radical operation should be the procedure of choice in cases of exostosis of the canal associated with chronic purulent otitis and in perforation of the premastoid lamina with necrosis of the posterior bony wall of the canal.

In his paper on the "Operative Treatment of Chronic Otorrhea," Page [18] gives this measure a prominent place. He thinks that the disease of the ossicles is not a menace to the health of the patient, but the diseased part around them, and he is disposed to perform the operation

18. Page (footnote 11, first reference).

tentatively in many instances, without too finely drawn pathologic limitation, when there is sufficient hearing to warrant it. He says:

> Even in cases where there has been great destruction of the drum membrane and marked changes in the tympanum, provided danger to the patient can be eliminated, let the conservative operation be tried, and time be allowed for regeneration of the drum membrane or the formation of cicatricial membranes to wall off the tube and effect a dry tympanum.

Fraser [13] says that it has been his practice to limit this operation to cases of chronic suppuration of the middle ear in which there was good hearing in the affected ear, or to cases in which the "other" ear was extremely deaf or more deaf than the ear to be operated on. In many of these cases the perforation is in the region of the attic or is a posterior marginal one; in both instances the lesion is frequently associated with cholesteatoma, so that a slight risk is incurred by omission to perform the complete operation. Fraser thinks, however, that taking such a risk is justifiable.

Simpson [9] believes that the modified radical operation is the one of choice when the ossicular chain is intact and the hearing is good. He says it is indicated in cases of double chronic suppurative otitis media in which the hearing is lost in one ear. He also thinks that a stricture of the external auditory canal in cases of chronic suppurative otitis is an indication for such an operation. He considers it particularly applicable if the patient is a child.

Beyer [19] says that this operation is seldom performed in Berlin. He considers this unfortunate, as unquestionably good results are obtained, and failure is not more frequent than when the complete radical operation is performed. Failure is usually due to errors in technic.

TECHNIC OF THE OPERATION

Stacke [1] says that whether or not a closed tympanum is obtained, which is his goal, depends entirely on the operative technic. As a rule, he removes the entire annulus or bony ring except when the fistula lies behind the short process. He then allows the anterior part of the outer wall of the attic to remain, in such a way, however, that the head of the malleus remains visible.

In his method of operation, he lays bare the external auditory canal and searches for the fistula in the drum. He then successively opens all the adjacent spaces, including the attic, aditus and antrum. Next he cuts away the entire bony covering of the antrum, leaving it wide open, so that every space is freely accessible, as in any radical operation; the posterior wall of the auditory canal is leveled down to the plane of the

19. Beyer (footnote 14, first reference).

facial nerve. He disturbs the ossicles as little as possible even when they are more or less covered with granulations, as is usually the case. He then makes an external plastic flap so as to have a large opening. The granulations spoken of usually shrink during the course of the after-treatment or through cauterization with silver nitrate or chromic acid. Stacke has seen carious areas in which the condition cleared up after the operation. In eight cases in which the long process of the incus was plainly carious and its connection with the stapes apparently loosened during the operation, he excised the incus; the tympanic membrane healed, and a closed tympanum was attained. Because of this, he designates as suitable for the operation those cases in which the chain of ossicles is already interrupted at the long crus of the incus, provided that the tympanic membrane and the malleus are well preserved. He thinks that the tympanic membrane becomes attached to the head of the stapes.

He usually operates with the patient under narcosis, but he has used local anesthesia, employing procaine hydrochloride with 2 drops of L. suprarenin synthetic bitartrate per cubic centimeter. Even when he uses narcosis, he previously injects this solution under the skin of the external auditory canal behind and above; this, he believes, prevents severe bleeding from the deeper part of the wound. He uses Thiersch's flaps in from the second to the fourth week. He inflates occasionally in the after-treatment in order to prevent broad adhesions of the tympanic membrane to the wall of the labyrinth. His period of healing is from five to thirteen weeks.

In his operation, Bondy [2] particularly avoids the luxation of the ossicles. His technic is to commence the operation as in performing a simple mastoidectomy. He does not detach the fibrocartilaginous canal until the simple operation on the mastoid has been completed; in this way the tympanic cavity is protected against injury from instruments or from the entrance of bony splinters. When the membranous canal has been detached, the bridge is chiseled through, the lateral wall of the attic is removed completely, the facial ridge is lowered almost to the plane of the insertion of the drum, and the plastic repair of the auditory meatus is carried out; both plastic flaps are fixed in their position by stitches so that strong pressure from the tampon is not required, and the retro-auricular wound is closed. Bondy says that care must be taken that the attic is laid bare as freely as when the complete radical operation is performed. He claims that if the arrest of the suppuration is not secured from this operation, owing to disease of the head of the malleus or of the body of the incus, it will be easy to create the conditions following the complete radical operation by an extraction of the ossicles carried out under local anesthesia.

Bondy's procedure has the advantage that the separation of the membranous canal occurs late in the operation, and protects the sound-conducting apparatus. Before the membranous canal is detached, the antrum is made free as far forward as possible, the entire lateral wall and the greater part of the anterior antral wall being removed, so that the horizontal semicircular canal is entirely visible, and the bridge is made as thin as possible. Another advantage is the complete removal of the lateral wall of the attic, since in some of the other modifications of the radical operation, the lateral wall of the attic is left untouched. Bondy says that the support of the drum membrane in the region of the Rivinian fissure depends not on bone but on ligaments, and that the removal of the external wall does not weaken the support of the drum. He says that after the operation the appearance of the drum is unchanged.

Bárány [8] says that if during the operation he discovers that the incus is no longer connected with the stapes, he removes the incus, and that if he finds that the head of the malleus is carious, he cuts it off at the neck and removes it. If the posterior upper half of the drum is destroyed, the preservation of the incus would be useless, and it should be removed. The distinctive points about Bárány's method are: The fibrocartilaginous canal is not detached during the operation; the plastic incision of the canal results in a flap folding downward; the first plastic incision is made along the facial spur, and thus the cutaneous lining of the lower and anterior walls of the auditory meatus remains intact.

Blackwell [20] uses the method of Bondy, but as he brings out certain points in the technic not yet elaborated, it may be of service to review his procedure. The postaural incision is made as in the Stacke operation. The soft parts anterior to this incision are elevated and pushed forward. The cortex is removed with a gouge, and the subcortical cells are removed with curets, until the antrum is exposed. The antrum is widened to its fullest extent, and the posterior wall of the canal is lowered. When the short process of the incus becomes visible as a result of the widening of the antrum, the external wall of the attic is removed by placing the back of the curet external to and in front of the incus, and curetting from within outward. The posterior wall of the canal is further lowered until the facial ridge is reached; the epitympanic ring in its superior portion is left, with a width of only about a sixteenth of an inch arching across the top of the drum from the posterior wall to the anterior wall of the canal. In his earlier cases, Blackwell allowed the epitympanic ring to remain, but during recent years he has removed it in nearly all instances, carefully separating it from the attached edge

20. Blackwell (footnote 8, second reference).

of the drum. The granulation, polypi and cholesteatomatous material lying in the external and internal attic are removed by curetting externally or internally to the malleo-incudal body, care being taken to preserve the suspensory ligament of the malleus. He warns one to exercise great care when cureting near the incus so as not to disturb the ligament binding the extremity of the short process to the bone below and just in front of the external semicircular canal. An L-shaped flap is cut as in the complete radical operation, the cartilage is removed, and the flap is sutured to the temporal fascia. The wound in the mastoid and the antrum are packed snugly, thereby furnishing support to the flap, and the postauricular wound is sutured.

Fraser [13] says that the modified radical operation has several variations: 1. After the antrum is opened, only a small part of the posterior wall of the bony meatus may be removed. 2. Almost the whole of this wall, including part of the lateral wall of the aditus, may be removed, the short process of the incus and the prominence of the horizontal canal being exposed. 3. The incus may be removed. 4. The outer wall of the aditus and attic may be taken away, the body of the incus and the head of the malleus being exposed. 5. Skin may or may not be grafted over the cavity.

Fraser thinks that the choice of operation depends on the type of case with which one has to deal, for in patients with perforation of the attic and cholesteatoma, it is advisable to follow the fourth variation and to remove the outer wall of the aditus and attic, whereas, in patients without perforation of the attic and cholesteatoma, a more conservative operation may be all that is needed.

Page [21] gives in detail his method of widening the canal when there is inflammatory atresia. After the separation of the fibrocartilaginous canal from the bony canal, he lowers the latter almost to the level of the horizontal canal. He next distends the fibrocartilaginous canal with gauze in order to facilitate incision. A transverse incision is made in the distended canal, 10 mm. above the level of the lowered posterior wall. He then incises in the long axis to the level of the lowered wall, and the flap is reflected over the facial ridge. All of the membranous canal external to the transverse incision is then removed, together with the thick tissues above and behind it, whereupon the semicircular incision in the concha is made to enlarge the meatus.

Beyer [14] curets the mastoid carefully, removing all diseased cells, and finally reaches the epitympanic recess. He carefully tampons the middle ear to guard it from injury by splinters of bone. He uncovers the epitympanic recess from the aditus forward until the tegmen can be seen and then chisels from before backward, that is, from the zygomatic

21. Page (footnote 11, second reference).

arch; he considers this a much safer method than the old one, in which one proceeded from within out, through the lateral wall. All granulations or cholesteatomatous masses are removed with a fine curet. The recess is sponged out rather than chiseled. The posterior wall is flattened to the level of the semicircular canal. The lateral wall is bitten off with the forceps; this is done extremely carefully if the wall is diseased, as, for example, in a case of marginal perforation. The body of the incus and the head of the malleus can then be seen, and with a fine curet it is possible to remove completely the granulations that may be present behind the ossicles. A plastic flap is made, and the operation is completed. Beyer favors the Koerner flap or the old Stacke flap with simple division of the canal, the upper and lower flaps being sutured with fixation sutures. The upper flap must be so adapted that the recess remains visible; the lower flap is placed on the spur.

Passow [22] thinks that in a radical operation the external canal should be made and kept rather wide and patent, especially if the cavity that has been made extends high posteriorly. It is difficult to prevent a postoperative narrowing, as at present packing is not done or is done loosely. As an aid, Passow has had a funnel-shaped, celluloid tube manufactured; this tube is pushed into the opening in the ear by the bandage, and by this means narrowing is avoided. He also advocates placing the skin flaps of the canal especially far back on the surface of the wound.

POSTOPERATIVE TREATMENT

On about the fourth day, Blackwell [10] removes the packing and thereafter dresses the wound every day. He merely cleanses the wound and insufflates powder. He warns that care should be taken to keep the antral and the attic regions as free as possible from granulations, as they are apt to become infected and to reinfect the middle ear, thus preventing its aeration. He notes that an interesting development in the process of healing is the growth of a secondary drum membrane in the attic region. It is his experience that when the interior of the mastoid has been permanently drained and aerated, marginal perforations involving half the drum will frequently heal. A primitive, natural effort seems to be made by the tympanic membrane to reconstruct itself when the cause of the destruction has been removed; this process is somewhat analogous to the restoration of the synovial membrane in cases of excision of a joint.

In this connection, I might call attention to some observations by Coates [23] on the regeneration of the membrana tympani. His conclusions

22. Passow (footnote 14, second reference).

23. Coates, G. M.: Regeneration of the Membrani Tympani, Laryngoscope, 1913, p. 692.

are: 1. Under certain favorable circumstances, perforations of the largest size may close spontaneously without adhesions, even years after the inception of the disease and the cessation of all discharge. 2. All tympanic membranes appear to have an inherent tendency to heal when the exciting cause is removed. 3. The reason for so many failures in the restoration of the continuity of the tympanic membrane is probably the lowered vitality of the tissues; better results may possibly be obtained if one strives to build up the general health of the subject and to improve the local condition before instituting active treatments. 4. The complete closure of a perforation is often of doubtful advantage because of the decrease in hearing, although better protection is afforded.

RESULTS OF THE MODIFIED RADICAL OPERATION

In considering this phase of the subject, it seems to me advisable that one should determine at the outset, the objects one wishes to accomplish. The most essential is to ensure the patient's safety by freeing him from the possibility of an intracranial complication. The other desiderata are to improve or at least to conserve the hearing in the ear on which operation has been performed, and if possible to arrest the aural discharge. The proponents of this procedure claim that these ends are attained in cases which are selected with even a moderate amount of good judgment. While success is fairly well assured in regard to the first and second of these results, one is less likely to obtain a dry ear with the modified than with the complete radical operation. It is only reasonable, for instance, to expect a slight discharge of mucus from the mucous membrane lining the middle ear in cases in which the perforation remains patent, but except for the slight nuisance occasioned the patient in keeping the ear dry, I cannot see that this condition causes him any hardship or danger.

Fraser [18] gives the following results of the modified radical operation on the mastoid, performed from 1907 to 1925 inclusive, at the Edinburgh clinic.

Recovery was uneventful in fifty-five of eighty patients; hemorrhage from the external meatus occurred in one; the posterior wound suppurated in eleven; serous labyrinthitis with recovery occurred in two; slight cellulitis in the auricle resulted in two, erysipelas in seven, and surgical scarlet fever in one; the outcome was fatal in one. In most of these cases, skin was grafted. The cavity was epithelialized and dry in 54 per cent of the cases; the outline of the inner wall was retained, and only one or two small areas of moist, pink mucosa were present in 33 per cent; therefore, a satisfactory result was attained in 87 per cent. Pus was present, with a swollen, congested mucosa or granulations, polypi and narrow meatus in 12 per cent. Hearing in the

forty-eight patients who returned for observation was affected as follows: improved in 70 per cent, same as before operation in 20 and worse in 8 per cent.

Beck [12] reports that in eighty cases in which he employed radical operations during a period of four years, he performed the modification operation in eighteen cases. He secured satisfactory results in 83 per cent; hearing was improved in 33, unchanged in 50 and worse in 16 per cent. The average healing time was six weeks. He makes a strong point of the fact that benefit was derived not only from the preservation of the drum membrane and ossicles, but also from the conservation of the tympanic cavity and its mucous membrane and fenestra.

Simpson [9] says that he has performed the modified radical operation during the eight years previous to his report on a number of cases, that the results have been gratifying, that he has not found it necessary to perform the complete radical operation later in any of the patients so operated on, and that the oftener he performs the operation, the more enthusiastic he becomes about the results. He also emphasizes the benefit derived from this operation in an anticipatory way in the prevention of complications in patients in whom the involvement is not serious enough to necessitate the complete radical operation, but who by this modified operation can be made at least comparatively safe.

Stacke [1] reports that he obtained a closed tympanum in forty-six of fifty-one patients; at the time of his report, the remaining five patients were still receiving treatment. Stacke, however, was much more rigid in the selection of his patients before operation, confining himself to those showing pathologic changes in the attic, aditus and antrum, and considering this operation contraindicated in cases of chronic perforations of the pars tensa. In patients with moderate hearing, he noted decided improvement in ten cases; the distance at which the patients could hear increased from 1.5 to 5 meters, from 0.5 to 6, from 3 to 7, from 0.75 to 3 and from 1 to 2 meters. The results were as follows: improved hearing in twenty, loss of hearing in two, unchanged hearing in twenty-four; in five cases, the patients were still under treatment.

In a report on the results in sixteen cases in which a modified radical operation was performed, Blackwell [20] divided the cases into two groups; (1) those in which the aural discharge had existed for more than five years and (2) those in which the discharge had been of less than five years' duration. In the second group, eight operations were performed; six ears had remained continuously dry since operation and two were intermittently dry; three of these patients showed improvement in hearing. In the dry ears, there had been much repair in the tympanic membrane, and he noted that a secondary tympanic membrane

had grown across the attic in the process of healing, closing off the attic from the mastoid cavity.

Bruhl [24] is in favor of the complete radical measure and believes that efficient operation and proper after-care will guarantee a lasting cure in an otherwise healthy patient. He does not attach so much importance to the closure of the tube as to the necessity of a wide open canal fashioned by a proper plastic incision. As far as function goes, he believes that ears which require operation have already been robbed of their function by the disease, and he maintains that allowing the ossicles and drum to remain is a sure way of preventing the hastening of complete healing and a lasting cure. He says that patients with hearing for the whispered voice at a distance of from 4 to 6 meters should not be operated on, but should be treated conservatively; and that if operation is indicated, they do not hear at that distance with the diseased ear, but with the other ear.

Von Eicken [25] agrees with Halle and Beyer that it is of benefit to preserve the ossicles in cases in which relatively good hearing is still present. He says that in certain cases of cholesteatoma with marginal defects high placed posteriorly and above, in which the condition cannot be healed through irrigation, it is proper at least to make an attempt to save the ossicles. He has used the modified operation in a series of cases with satisfactory results.

Claus [26] also is in favor of the modified radical operation. He brings out the point that the end-results are better in private patients than in hospital patients. The private patient is more apt to follow instructions and will report for treatment as often as is necessary; mixed infection is avoided, and hygienic conditions generally are better.

Schötz [27] reports having performed the modified radical operation with the best results; he later observed soldiers on whom the modified radical operation had been performed and noted their greater power of resistance as compared with those on whom the complete radical operation had been done.

Beyer [28] reports that he performed modified radical operations on about fifty patients during the year before his article was written, and that he had not had to operate again in any case. Two of the cases in which he had performed operation were presented at a society meeting; one patient had a cholesteatoma which had broken through into the canal; the other, a child, had meningeal symptoms accompaning a cholesteatomatous mastoid with a carious tegmen.

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24. Bruhl (footnote 14, second reference).
25. Von Eicken (footnote 14, second reference).
26. Claus (footnote 14, second reference).
27. Schötz (footnote 14, second reference).
28. Beyer (footnote 14, second reference).

THE HEATH OPERATION ON THE MASTOID

The procedure used by Heath is, in reality, a form of the modified radical operation, although its originator uses it in place of the simple mastoid operation in cases of acute suppurative mastoiditis as well as in those of subacute and chronic otitis media with mastoiditis. The steps common to Heath's method and the modified operation are: free exposure of the antrum, lowering of the posterior wall, production of a plastic flap and drainage through the external auditory meatus; they are all of service in the class of cases which are being considered. Heath's method falls down woefully, however, in its incompleteness as far as the entire removal of the cells is concerned; in most mastoids this would be impossible with his technic. Why should one thus handicap oneself unnecessarily?

Technic of Heath Operation.—The best description of this operation is found in a paper by Richards,[7] of which the following is an abridgment.

> The preparation is as usual, except that no hair is removed. A rubber sheet perforated with holes for the ears is shaped to make a cap and covers the hair. The incision is commenced one third of an inch behind the temporal artery, on a level with the highest attachment of the ear to the scalp, and is carried backward to that point, thence in the angle formed by the junction of ear and scalp, until it reaches the level of the bottom of the concha. The incision is through skin only; the temporal fascia is maintained intact. The concha being held on the stretch, the concha and membranous canal are detached from the fascia. A periosteal flap is then made, the base being in a line from the suprameatal spine parallel to the posterior wall of the canal, to a little below the floor of the canal. Parallel incisions, about three quarters of an inch in length, are made from the upper and lower boundaries of this base. This rectangular flap is detached and retracted out of the way. The membranous canal is next dissected from the bony canal and retracted.
>
> The antrum is opened and explored. The mastoid cells are not completely exenterated, only those appearing diseased or those which would interfere with drainage being removed. The cleansing of the antrum is regarded as the most important step of the operation, and is done with specially made burrs. The posterior bony meatal wall is then removed to within a quarter of an inch of the drum membrane. The drum and ossicles are now studied and polypi if present are removed. The floor of the bony external auditory canal is lowered enough to give it a slight downward and outward direction. The antrum and aditus are syringed through; a flap is cut in the membranous canal to cover the floor and part of the back wall of the bony external canal; this meatal flap is stitched to the periosteal flap. The external meatus is enlarged by incising the crux of the helix far enough to allow a five-eighths inch rubber drainage tube to enter; this tube is left in situ for some time. The wound is sutured, and the operation is complete.

COMMENT

Heath has been one of the pioneers in pleading for the conservation of hearing and has done a great service in stressing to the

medical profession at large the danger of a laissez faire attitude toward patients with discharging ears, in regard to the preservation of the auditory function and the risk to health, if not to life, incurred by them.

REPORT OF CASES

It may be interesting to cite the following reports of cases in which the patients have come under my care contemporaneously with the writing of this paper.

CASE 1.—R. McC., a woman, aged 22, a stenographer, had a right purulent otitis media of one year's duration, during which time she had been under treatment constantly. Physical examination showed a large polyp, posterior inferior quadrant; about one third of the drum membrane had disappeared in this region. On June 25, 1927, a modified radical operation was performed. The observations were: antrum and attic diseased; incus and malleus apparently normal. In six weeks, the ear was dry. Ten weeks after operation, all the hiatus in the drum membrane had completely cicatrized over, and the tympanum was closed. Before operation, a low whisper had been heard at a distance of 12 feet, and at the time of discharge it was heard at a distance of 24 feet.

CASE 2.—V. E., a girl, aged 15, had a double, chronic, purulent otitis media of nine years' duration, following scarlet fever. Physical examination showed that in the right ear, nearly the entire drum had disappeared; in the left ear, there was a large central perforation in the membrana tensa. An operation was performed on June 11, 1927. A complete radical operation was performed on the right ear, except that the mucous membrane of the tympanum and of the tube was not cureted; a modified radical operation was performed on the left ear. The following condition was found: necrosis of the antrum and of the tegmen tympani of the right ear, and no trace of the malleus and incus; necrosis of the antrum and of the tegmen tympani of the left ear, in which the malleus and incus appeared normal. Before operation a low voice was heard by the right ear at a distance of 6 inches; by the left ear, a low whisper was heard at a distance of 3 inches Three months after operation a low voice was heard by the right ear at a distance of 3 feet; a low whisper was heard by the left ear at a distance of 1 foot; at the time of writing, the right ear was discharging slightly; in the left ear, there was a watery discharge, and the drum membrane had not regenerated.

CASE 3.—H. C., a boy, aged 13, had a right, purulent otitis media of three years' duration. Physical examination showed a large, central perforation. On June 27, 1927, a modified radical operation was performed. The mastoid, antrum and attic were found extensively diseased; the incus and malleus were apparently normal. In four weeks the ear was perfectly dry. Before operation, a low whisper had been heard at a distance of 6 feet; ten weeks after operation, there was not any change; the drum membrane had not regenerated at that time.

The detailed history in the following case is somewhat irrelevant to the subject, but it has some unusual phases; so I venture to submit it.

CASE 4.—F. A., a girl, aged 2½ years, was first seen by me on Feb. 15, 1927, at her home. She was suffering from a right-sided subperiosteal mastoid abscess, complicating an attack of pertussis in its acute stage. The child was operated on that day at her home. Nothing unusual was found; the inner table was necrotic; the sinus was necessarily exposed, and looked healthy. Seven days

later, bronchopneumonia developed, and during a severe paroxysm of coughing the sigmoid sinus ruptured. The patient had a severe hemorrhage, which was arrested by tight packing. Twelve days later, the sigmoid sinus again ruptured during a coughing spell, and the patient was nearly exsanguinated. On the twentieth postoperative day, she was moved to the hospital, as the pertussis had passed the infective period, and a transfusion of 300 cc. of blood was made. On the twenty-sixth day, another transfusion with the same amount of blood was performed. As a pyemic temperature developed, a blood culture was taken, which was reported positive for *Streptococcus hemolyticus* on the twenty-eighth day. Following the second transfusion, the temperature improved materially, until about the thirty-sixth day, when it again became septic. Abscesses then began to appear on the body in various regions, and her condition seemed desperate. On the forty-third day, after a third transfusion of 300 cc. of blood, I ligated the internal jugular vein with the patient under procaine hydrochloride anesthesia, as I was not able to use general anesthesia on account of unresolved bronchopneumonia. This did not make any material change in the child's condition. Abscesses kept appearing, and during the child's illness, she had more than two dozen abscesses; most of them contained large quantities of pus, and drained for long periods of time. *Streptococcus hemolyticus* was invariably present.

On the sixty-eighth postoperative day, the patient was again given a transfusion of 300 cc. of blood. On the ninety-fourth day, after another transfusion, I operated on the left mastoid under procaine hydrochloride, as an infection had developed on this side. Bronchopneumonia then developed on the opposite side.

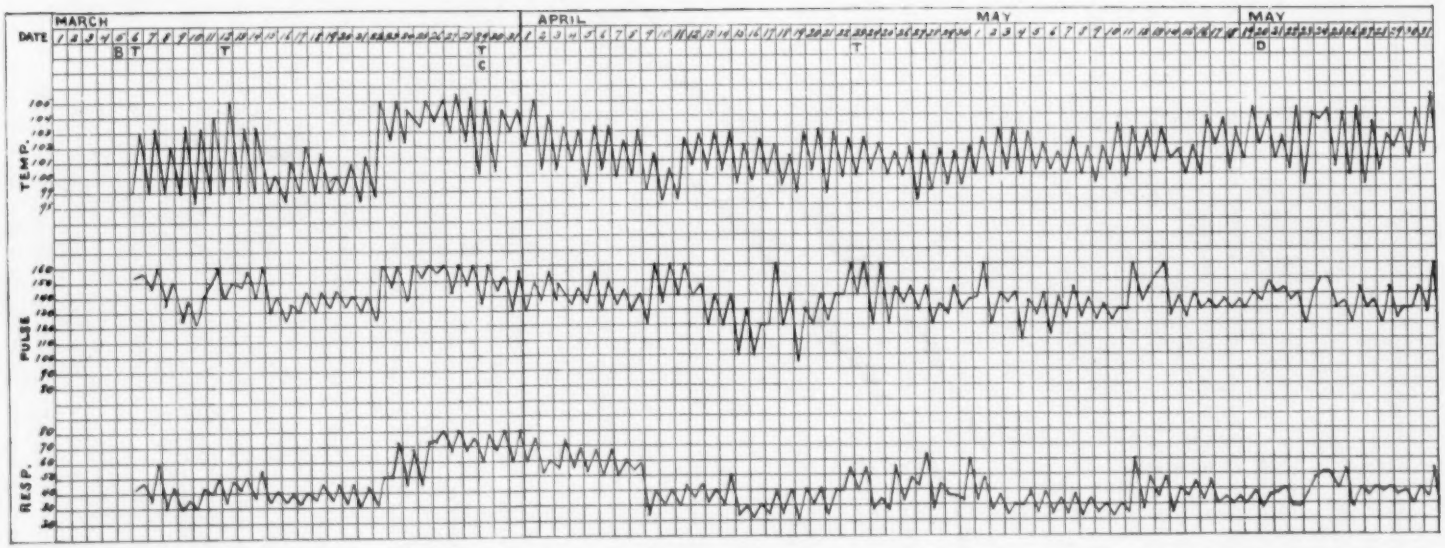
During all this time, the patient was being treated with many adjuvants, such as injections of hypertonic physiologic solution of sodium chloride, injections of autogenous vaccine, exposure to the Alpine light and exposure to the sun through the vitaglass.

On the one hundred and forty-eigth day, as her condition was improved, and as the original mastoid wound on the right side was open and discharging with an aural discharge, I performed a secondary mastoid operation. The wound did not heal, and on the one hundred and ninety-fifth day, I performed a modified radical operation. At that time, the condition was as follows: discharging sinus behind the ear leading to the exposed bone, discharge from the canal and most of the drum gone. One week later, or on the two hundred and first day, the patient was discharged from the hospital in good general physical condition; the postaural wound had healed, with the tissues solid and without deformity. Five weeks after this last operation, the ear was completely dry.

COMMENTS ON REPORTED CASES

I think that most otologists would have performed a complete radical operation in case 1. Polypi had been removed more than once and had recurred. The perforation was large and was located in the pars tensa. The hearing was so good, however, that I thought it worth while to attempt a cure by the modified operation, and was fortunate enough to attain an ideal result, a closed tympanum and an improvement of 100 per cent in hearing.

Case 2 is illustrative of another type of disorder. I had to deal with the problem of an infection in both ears of nine years' duration; that in the right was severe, and the left ear was considerably involved,



Part 1

Part 2

Curves showing variations in respiration, pulse rate and temperature for patient in case 4. *B* indicates when rupture of sinus occurred; *C*, ligation of jugular vein; *T*, transfusion; *D*, operation on the mastoid of the left ear; *E*, secondary operation on the mastoid of the right ear; and *F*, modified radical operation on the mastoid of the right ear.

but the ossicles were apparently intact. As great impairment of hearing was present, the question of conservation of auditory function was vital. As to the ends accomplished by the modified operation, the removal of extensive necrosis in the roof of the middle ear was of benefit. Perhaps some caries are left in the ossicles, as is evidenced from the continuance of the discharge, although this is greatly modified. With the increased amount of air and light on the draining area, however, the tympanum may become dry in time and the drum membrane may cicatrize over; Blackwell says that this often happens many months after the operation. Besides being in practically no danger from necrosis, the patient has also obtained a slight amount of improvement in hearing.

In case 3, the operation removed the necrosis and, in four weeks' time, brought about cessation of a discharge which had lasted three years. Improvement was not obtained in the hearing, but this was comparatively good at the time of operation and probably would have suffered considerably had the complete operation been performed.

Case 4 has several interesting points outside of the subject being considered: the rupture of the exposed sigmoid sinus, its repetition with nearly fatal hemorrhage, pyemia with multiple abscesses and recovery after seven months of continuous sickness. I have seen sinuses rupture spontaneously in other cases, but in them there was enough evidence to justify the diagnosis of septic phlebitis. In this child, there was not any basis for assuming the presence of that condition, and I feel sure that the rupture was caused by the effects on the exposed vessel of the increased blood pressure brought about by severe paroxysms of coughing. I think that this accident is rare and the possibility of it happening should be borne in mind. Tight packing of the mastoid wound seems to be indicated in cases like this one. The child's wound did not heal until a modified radical operation had been performed, although she had had a thorough secondary simple operation on the mastoid which left a discharging sinus high up in the scar.

CONCLUSIONS

1. There is a distinct well proved niche in otologic surgery for the modified radical operation on the mastoid.

2. In this country, the operation has not had the following it deserves, but its advocates, though few in number, are warmly enthusiastic about their results.

3. This want of popularity is principally due to a lack of information concerning its indications, technic and results.

4. The modified operation is particularly indicated in cases of chronic otitis with small perforations in the upper part of the drum,

when the hearing is still good, that is, the voice can be heard at a distance of 2 meters or more.

5. The modification can also be tried on patients with good hearing when the other ear is severely compromised, even though the perforation may be located less favorably.

6. In nearly all cases of the former class and in many of the latter, a dry ear with cicatrization of the perforation and an improvement in, or at least a conservation of, the power of hearing may be expected.

7. The results as to audition through the preservation of the drum and ossicles are much superior to those obtained by the complete radical operation, and the postoperative healing time is much shorter.

2 East Fifty-Fourth Street.

MULTIPLE PRIMARY CARCINOMAS OF THE LARYNX AND ESOPHAGUS

REPORT OF A CASE *

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Multiple growths occur in 4.7 per cent of all cases of malignant neoplasms, according to Owen.[1] These figures are much higher than those for multiple primary carcinomas alone which are found to occur in only 0.5 per cent of all cases by von Hansemann [2] and in 0.4 per cent by Redlich.[3] The basal cell type of squamous cell carcinoma is by far the most common of the carcinomas, and although the case herein reported is of this type, the infrequency of malignant changes occurring simultaneously in the esophagus and larynx is worthy of note. It is well known that multiple primary tumors of the same type, i. e., carcinomas, more frequently attack a single organ than they do separate organs of the same or different systems. This higher percentage is due, perhaps, to the more frequent involvement of the skin by multiple primary carcinomas. With considerably less frequence are organs of different systems found to be the seat of multiple primary tumors simultaneously, and quite rarely do multiple primary tumors of different types, i. e., carcinomas and sarcomas, occur simultaneously.

The literature on primary multiple tumors has been adequately reviewed by Owen,[1] Major,[4] Herley [5] and Bertocchi,[6] and further summarization need not be made. The occurrence of multiple primary carcinomas which involve the respiratory and digestive systems together is rather infrequent. Goetting [7] reported a case in which the larynx,

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1. Owen, L. J.: Multiple Malignant Neoplasms, J. A. M. A. **76**:1329 (May 14) 1921.

2. Von Hansemann: Das gleichzeitige Vorkommen verschiedenartiger Geschwülste bei derselben Person, Ztschr. f. Krebsforsch. **1**:195, 1904.

3. Redlich, W.: Die Sektions-Statistik des Carcinoms am Berliner Städtischen Krankenhaus am Urban, nebst kasuistischen Beiträgen, Ztschr. f. Krebsforsch. **5**:261, 1907.

4. Major, R. J.: Multiple Primary Malignant Tumors, Bull. Johns Hopkins Hosp. **29**:223, 1918.

5. Herley, L.: Multiple Primary Cancers, Arch. Surg. **9**:204 (July) 1924.

6. Bertocchi, A.: Contributo allo studio dei tumori multipli maligni diversi generis, Policlinico (sez-chir) **29**:361 (July) 1922.

7. Goetting: Zur Multiplizität primärer Carcinome, Ztschr. f. Krebsforsch. **7**:675, 1909.

pylorus and rectum were simultaneously involved, and von Hansemann [2] described a case in which carcinoma of the stomach and carcinoma of the bronchus were present.

Carcinoma of the esophagus is more frequent than carcinoma of the larynx, and the former when occurring with other primary carcinomas is more often coincident with carcinoma of the stomach than with carcinoma of any other organ. The occurrence of primary multiple carcinomas of the larynx and esophagus has, as far as I am able to determine, been recorded but twice in the literature. Ziba Schin-izi,[8] in 1911, reported two cases. The first was that of a patient with an adenocarcinoma of the esophagus associated with a squamous cell carcinoma of the larynx, and the second a patient with primary carcinomas of the esophagus and trachea. His descriptions are complete and contain full pathologic reports.

As to the origin of multiple primary tumors, there are many theories; these are adequately discussed by Herley,[5] who summarizes them as follows: The possibility of metastasis from a primary growth must always be remembered, for metastases often leave no trail. Organ—and individual—predispositions to tumor formation may be responsible, and these may be the products of inherited constitutional predisposition. More specifically, certain structural derangements may be responsible, as, for example (*a*) prenatal developmental irregularities, (*b*) local hyperplastic lesions as those due to irritants and (*c*) multiple benign tumors, which, of course, are frequent. The real etiologic facts must, of course, remain hidden until the origin of malignant tumors can be accounted for.

Constitutional or environmental factors were not present to arouse suspicion in the reported case, so that the etiology might not be explained in the way. There is enough evidence to indicate that neither lesion was metastatic and that the growths were primary multiple carcinomas of the basal cell type. It is interesting, in this connection, to recall a case reported by Maxon.[9] He gave a full description of a primary carcinoma of the esophagus which had ruptured through the trachea. As a result, many small carcinomas of the same type were found in the lower lobes of both lungs. That they were doubtless due to the inhalation of carcinoma cells seems probable, because of the fact that the pulmonary growths were all microscopically similar to that of the original tumor and the metastases were distributed, unlike those of ordinary pulmonary metastases, to the center of the lobules of the lungs.

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8. Ziba Schin-izi: Ueber die Kombination von Larynx- bzw. Tracheal-Carcinom mit Oesophaguscarcinom, Arch. f. Laryngol. u. Rhinol. **25**:401, 1911.

9. Maxon, W.: Case of Transplantation of Epithelial Carcinoma from Trachea to the Pulmonary Tissue Probably by Descent of the Carcinoma Germs Down the Bronchial Tubes, Tr. Path. Soc. London **20**:28, 1869.

REPORT OF CASE

History.—W. G., aged 50, an American white man, married, was seen first by his family physician, complaining that for three months prior to October, 1926, he had had pain in the chest after swallowing food. He said that an x-ray examination made at that time showed "stenosis in the cardiac end of the esophagus." (I do not have any more definite data in regard to this examination.) Two weeks prior to October, 1926, he consulted another physician because of hoarseness; he was then sent to the otolaryngological and medical dispensaries of the University Hospital for examination. He had been hoarse over a period of from eight to nine years, according to his story. The hoarseness was gradual in onset and was most marked in the morning, in damp weather and after much talking. There had not been any sudden change recently, although he had developed an occasional cough, without expectoration and without pain. He had suffered from night sweats for about six to eight months, and had lost 20 pounds (9 Kg.). Slight dyspnea was noted on exertion. For some time, he had had considerable localized aching pain in the epigastrium after meals. At the time of the examination, he was taking liquid food only, because of pain in the chest when he swallowed solid food. Some diarrhea had been present during the preceding week.

Examination and Course.—Because of his weak condition and his obvious need for care in the hospital, he was admitted to the medical ward. Examination at that time revealed: temperature, pulse rate and respiration, normal; weight, 90 pounds (41 Kg.), and blood pressure, systolic 134 and diastolic 88. He was obviously weak and emaciated. The head and neck were normal. The chest showed poor development, but equal expansion bilaterally, with impairment of percussion over the upper lobes and especially the apexes. Anteriorly and posteriorly the breath sounds were bronchovesicular at the right apex and less so at the left. There was an increase of both tactile and vocal fremitus, but otherwise the observations in the chest were negative. The abdomen was normal. The rectal examination showed hemorrhoids externally. The tentative diagnosis at that time was chronic fibroid tuberculosis, malnutrition and possible malignancy or tuberculosis of the lower part of the esophagus or the stomach.

Laboratory data were as follows: red blood cells, 3,760,000; white blood cells, 12,200; hemoglobin content (Sahli), 71 per cent. The differential count was normal. The urine was normal save for a faint trace of albumin. The Wassermann reaction in the blood was negative. Tubercle bacilli were not found in the sputum or stools. The gastric analysis showed an achylia. X-ray of the chest was reported as "negative except one small area in the right apex shows mottling. May be a tuberculous lesion."

The results of an examination with a mirror laryngoscope on Oct. 25, 1926, were reported by Dr. Tucker as follows: "Examination of the larynx shows a mass the size of a split pea attached to the anterior third of the left vocal cord on its free margin and lower surface. The mucosa of the larynx generally is pale and thickened throughout. There seems to be slight impairment of motion of the left cord particularly in the region of the enlargement. The mirror examination is characteristic. If there is an active tuberculous lesion in the lungs it is very probably tuberculous. However, it would be necessary to remove a specimen for biopsy in order to determine this."

X-ray of the gastro-intestinal area on October 25 showed: a normal esophagus, ptosis of the stomach, a normal duodenum, hypermotility of the colon and evidence of mucous colitis. The proctoscopic examination yielded negative results.

At this time it was thought that the whole picture could be explained on the basis of a widespread tuberculosis, especially as the physical examination of the lungs persisted in showing widespread involvement—more than the x-ray indicated. The enteritis cleared up shortly after the patient was admitted to the hospital.

On Nov. 3, 1926, direct laryngoscopy was performed by Dr. G. Tucker, and a specimen for biopsy was removed. This specimen consisted of two pieces of tissue (as described in the pathologic reports, sections 1 and 2), and showed a basal cell carcinoma and a leukoplakia of the larynx. Laryngofissure was advised, but because of his great weakness and his complaints of substernal pain and discomfort this was delayed. Owing to the persistence of these symptoms and despite negative x-ray observations in the esophagus, it was decided to do an esophagoscopy. This was done on Nov. 19, 1926, by Dr. G. Tucker, and an ulcerative lesion was revealed just above the level of the diaphragm at a point 40 cm. from the upper teeth. It had the appearance of a neoplasm. A biopsy specimen taken at this time showed inflammatory tissue only. Four days later, another esophagoscopic examination was made, and a biopsy was performed. This specimen (as described in the pathologic reports, section 3) showed a basal cell carcinoma.

He continued to get worse and to lose weight, and it was decided that nothing could be done in a surgical way to relieve him. Another x-ray examination of the esophagus was made and reported on as follows: "The bismuth capsule lodged at the site of the lesion in the middle third of the esophagus. Bismuth and buttermilk mixture passed down without dislodging the capsule. In the Manges position the defect was clearly shown the lesion being quite large and extending over an area of approximately 7 cm. Diagnosis carcinoma of the middle third of the esophagus."

On Dec. 1, 1926, the patient was discharged from the hospital and unfortunately did not appear for follow-up examination. He died at home on Feb. 18, 1927. A postmortem examination was not made, and the immediate cause of his death was not recorded.

Pathologic Reports.—Microscopic examination of the biopsy specimens was reported as follows:

Section 1, Larynx: The tissue showed an epithelial hyperplasia invading a definite submucous layer of fibrous and areolar tissue. The epithelial cells were definitely of the basal type, arranged in irregular groups and somewhat demarcated from the surrounding tissue, but not by the narrow fibrous-like layer separating normal epithelium from the deeper tissues. The cells at the periphery of the groups or islands, many of which were in apposition, were columnar in type; those in the center were polygonal and not so clearly stained. The cells were irregular in contour; the cytoplasm was vacuolated, and the nuclei were of many shapes and sizes and in nearly all instances more deeply staining and relatively larger than normal. All the cells except the basal cells had lost their polarity, and not in any instance was there simulation or imitation of any normal tissue or structure. There was a slight amount of inflammatory reaction and considerable increase in vascularity.

The diagnosis was basal cell carcinoma.

Section 2, Larynx: The tissue was mucous membrane in which the epithelial layer was thicker than normal, largely as a result of an increase in the number of polygonal and particularly squamous cells. The cytoplasm of the squamous cells was vacuolated and stained poorly, and there was a definite tendency for the cell layers to split which was suggestive of leukoplakia. The basal layer of cells was thin, the nuclei were deeply stained and in one or two places there seemed to be a beginning blunt digitation of the subepithelial layers by these cells. The cells were a little irregular in size and shape, the nuclei varying in this way also.

There was, however, no actual invasion as yet, and no true tumor in the section. The subepithelial tissues showed an increase in fibrous tissue, and there was a marked inflammatory reaction.

The diagnosis was leukoplakia and inflammatory tissue.

Section 3, Esophagus: The section consisted of a mixture of fibrous tissue strands and deeply staining basophilic epithelioid cells arranged in such a way that they did not represent normal tissue. The cells resembled basal epithelial cells more closely than any other type, for they had deeply staining nuclei which were irregular and of varying sizes, and in some instance showed evidence of mitosis. The cytoplasm was also basophilic and vacuolated, and the cells had lost their polarity and were entirely undifferentiated. The fibrous strands coursed between the epithelioid cells, and they were, in most cases, several layers thick, the layers often being frayed at the ends by an invasion of the epithelioid cells. The tumor was a diffuse carcinoma, in general construction nondescript, but in cellular type most nearly approaching basal cell carcinoma. It was, however, distinctly different from the tumor described in section 1.

Several points should be emphasized. In the first place, it seems highly improbable that either lesion was metastatic. Carcinoma of the anterior two thirds of the vocal cords metastasizes to the lymphatics and lymph nodes about the cricothyroid membrane, while that of the esophagus metastasizes to the posterior mediastinal, prevertebral and lower deep cervical nodes. Both these lesions are late in metastasizing and, in addition, the types of basal cells found in each of the biopsy specimens were quite different.

Early examination of the larynx of a patient who has been hoarse for any length of time is important. It is only in this way and with biopsy of early and suggestive lesions that early diagnosis and cure can be obtained. The patient in the case reported had been hoarse for a number of years before the nature of his lesion was discovered. According to Tucker,[10] the average length of time between the onset of symptoms in carcinoma of the larynx and the time of diagnosis is eleven and a half months.

Perhaps the most important thought in regard to the reported case is the demonstrated value of biopsy in an ulcerative laryngeal lesion. The presence of tuberculosis seemed highly probable in this case, not only from the general medical examination, but also from examination with a mirror laryngoscope. Only by direct laryngeal examination and the study of a biopsy specimen was the diagnosis of carcinoma made.

SUMMARY

A case of multiple carcinomas of the larynx and esophagus, proved by biopsy and pathologic study, is reported. It is understood that this is an exceedingly rare localization for such primary multiple carcinomas.

10. Tucker, G.: Cancer of the Larynx, Surg. Gynec. Obst. **46**:303 (March) 1928.

THE INCIDENCE OF NASAL SINUSITIS WITH DISEASES OF THE EAR

ONE HUNDRED CASES IN CHILDREN *

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An intimate knowledge of what is transpiring in a diseased ear and in a diseased nose is acquired by the study of complete histories, with otorhinoscopy, functional tests and audiograms by air and bone conduction, and by stereoroentgenograms. All of these must be repeated for follow-up observations.

Though the problems of deafness in the adult are better understood, prevention and treatment are less effective than in children. If progressive deafness is to be mastered, the periods of its inception and preinception will furnish the most promising grounds for research. Any deafness may become progressive in some degree, and it is not yet known when or why any deafness may presage permanent or progressive deafness. For these reasons, a study of the ears of children is desirable, and any correlation that may be established between the disease of the ear and factors heretofore thought incidental should be of some value. The known intimate relation between the ears and the nose and nasopharynx indicates that a more than casual glance should be focussed on all the nasal spaces.

One hundred consecutive cases in children, in which the patients were examined by the methods already mentioned, have been chosen for discussion, with particular attention to the nasal sinuses. Chart 1 shows the upper half of a history chart and the method of filling in. The Wassermann tests, blood counts and blood chemistry were also made at first as a routine, and later in special cases, but the results will not be mentioned further at this time.

A special chart was devised for the x-ray observations, as shown on the left side of the lower half of chart 2. These charts have forced definite and complete observations on the points desired; a graphic representation of the hearing sensitivity for both ears on successive dates is registered, and the place and degree of abnormal shadows are indicated. The diagnosis chart on the right is usually sufficient to cover all contingencies. Such charts save time and yet register complete data.

DISEASE GROUPS

The histories in these 100 cases (200 ears) were arranged in five groups, according to the diagnosis of the dominant ear disease (table 1).

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* Read before the Trialogical Society, Washington, D. C., May, 1928.

Chart 1.—Upper half of history chart. In these charts a check calls attention to a disease, symptom or fact; a (V) pointing to the right side of the chart (<) indicates large, thick or increased (<<< very thick), and a (V) pointing to the left side of the chart (>) indicates small, thin or diminished (>>> very thin).

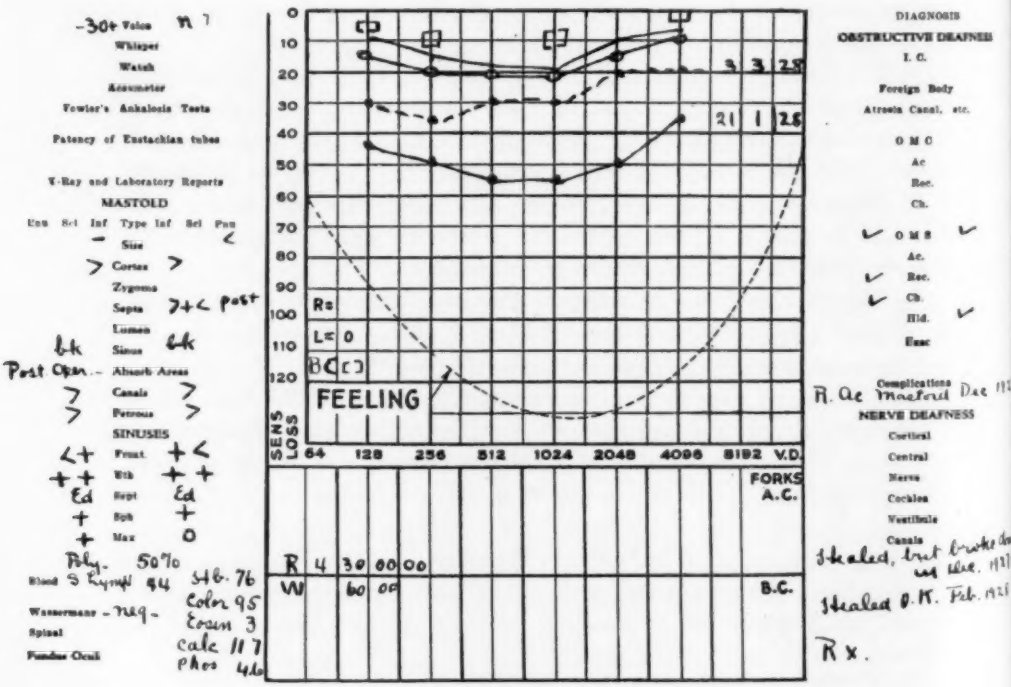

Chart 2.—Lower half of history chart.

Average Age	Diagnosis	No.	Average Sensation Units Loss in Hearing R.	L.	Discharge or Pain or Treatment	Exanthemas	Colds, Influenza	Pneumonia	Mastoid Operation	Vertigo	Tonsils, Adenoids Removed
11 (8-17)	Nonsuppurative otitis media	5	19	17	0 3 = 3	4	5	0 = 5	0	0	2
11 (3-18)	Healed suppurative otitis media	37	36	38	15 7 = 22	24	15	6 = 21	0	8	17
11 (6-18)	Recurrent suppurative otitis media	34	32	33	31 3 = 34	22	22	4 = 26	3	0	19
9 (6-14)	Chronic suppurative otitis media	13	40	39	13 5 = 18	7	7	2 = 9	1	1	7
10 (2-19)	Nerve	11	71	87	3 3 = 6	8	5	0 = 5	3	3	8
11		100			78%	65%	68%		7%	12%	53%

Average Age	Mastoid Type	Septums	Lumen	Separate Cases	Absorbed Areas	Totals
	P. S. I.	R. L.	R.	L.	R. L.	
11 (8-17)	R. 2 0 3 L. 2 0 3	2 2 2 2	4 1	3 1 0 abnormal	1 K-A 0	= 1
11 (3-18)	R. 27 5 5 L. 26 6 5	R. L. 7 6 20 22 1 edematous 1 2 1 osteitis 1	R. 1 ++++ 5 ++ 5 +	L. 0 1 3 7 4 6 14 abnormal	R. L. 8 K-A 6	= 9
		3 abnormal				
	Some involvement	0.8%		38%		
	Moderate or severe			21%		
11 (6-18)	R. 23 5 6 L. 17 9 8	R. L. 8 9 9 9 2 absorption 3 3 1 osteitis 1 1 1 edematous 4 4	R. 4 +++ 2 ++ 4 + 1 chronic 1 condensing	L. 2 4 6 5 4 4 0 1 0 1 19 abnormal	R. L. 9 6	= 11
		8 abnormal				
	Some involvement	23%		56%		
	Moderate or severe			39%		
9 (6-14)	R. 7 4 2 L. 8 3 2	R. L. 2 2 2 3 1 absorption 0 1 1 condensing 1 2 0 edematous 1 1	R. 2 ++++ 2 +++ 2 ++ 1 +	L. 1 2 0 2 3 2 1 2 8 abnormal	R. L. 4 K-A 1	= 5
		4 abnormal				
	Some involvement	31%		61%		
	Moderate or severe			46%		
10 (2-19)	R. 8 0 3 L. 8 0 3	R. L. 4 1 3 6 2 edematous 0 2 2 absorbtion 0 2	R. 1 +++ 2 ++ 1 +	L. 0 1 0 2 0 1 4 abnormal	R. L. 1 0	= 1
		4 abnormal				
	Some involvement	30%		30%		
	Moderate or severe			27%		
	Totals moderate or severe involvement	19%		32%		27%

* In this and the subsequent tables the increased shadows denoting involvement of the spaces, normally transparent, are indicated as 1, 2, 3 and 4 by a corresponding number of plus marks, +, ++, +++ and++++. These indicate slight, moderate, moderately severe and severe involvement, respectively.

There were 5 cases of nonsuppurative otitis media, 37 of healed suppurative otitis media, 34 of recurrent suppurative otitis media, 13 of chronic suppurative otitis media and 11 of nerve deafness. The diagnosis was made not alone from the immediate pathologic conditions presented, but also from the whole history of the case. The results of the x-ray examinations were interpreted by Dr. Frederick M. Law, without knowledge of the clinical diagnosis. In table 2, a summary is given of the observations in the 100 cases. The youngest patient was 3, the oldest was 19 and the average for the group was 11 years.

The number and proportions in each disease group may be studied by reference to table 1, which also contains detailed data concerning the type of mastoid, the thickness of the septums and of the mastoid cells, the degrees and percentages of involvement in the lumen of the mastoid cells and the presence of osteitis or cholesteatoma. The number of cases in

TABLE 2.—*Summary of Observations in One Hundred Cases*

	Sound Units
Average sensation unit loss in each ear, as determined from the audiogram.....	Right 35 Left 36
	Per Cent.
History of discharge or pain (or treatment indicating pain).....	78
History of exanthemas	65
History of colds, influenza and (or) pneumonia.....	66
History of mastoid operations	7
History or vertigo	12
History of tonsil and adenoid operations.....	53

which the right and the left mastoid or both were abnormal is also given for each group.

Thirty-two per cent of the cases showed more than a slight involvement of the cell lumen (forty-five ears); this was in direct ratio to the chronicity of the suppuration. Twenty-seven per cent showed areas of absorption (thirty-seven ears), which were about the same proportionately in all the cases of suppuration. Nineteen per cent showed abnormal septums in the mastoid (twenty-three ears). This was in direct ratio to the chronicity of the suppuration.

Besides the eleven cases in the nerve deafness group, there were seven cases of nerve deafness in the suppurative group. In the nerve deafness group there were six cases with past histories of suppurations, so that 78 per cent of the patients gave a history of discharge or earaches.[1]

In the suppurative groups, all of the patients gave histories of suppuration, with the exception of fifteen in the group of thirty-seven cases with healed suppurations. The diagnosis of a prior suppuration in these

1. In school children generally, the percentage of suppurative disease of the ears is high, irrespective of their hearing capacity. Fowler, E. P.: Deafness in School Children, Arch. Otolaryng. **6**:43 (July) 1927.

fifteen cases was made from scars, perforations, or adhesions of the drum membrane. Fifty-seven per cent of the patients with healed suppurations had had repeated attacks of cold or pneumonia, whereas 70 and 73 per cent of those with chronic and recurrent suppurations, respectively, had had repeated attacks of cold or pneumonia. In the five cases of chronic nonsuppurative otitis, 100 per cent of the patients had had repeated colds and 60 per cent, a history of earache. It is probable that all of these patients had suffered from infection of the ear.

It may be noted that there was no diagnosis of otosclerosis. Only four of the patients were over 16 years of age. Except for the cases of nerve deafness, the average losses in hearing acuity were not excessive.

Many of the symptoms and x-ray observations apparently were of little present interest, and were omitted from the table. The histories and x-ray observations on the mastoid are about what would have been expected in children.

Table 3 gives a detailed summary of the x-ray observations in the nasal sinuses. Under each heading, the figures before the x indicate the number of cases of each degree of involvement of the bony spaces. The upper and lower percentage figures show the percentages of slight and more than slight involvement, respectively, of the sinuses, in relation to the diagnosis of the specific ear condition. A special feature is the notation of condensing osteitis, absorption and edema of the ethmoid septums, and the percentage of these found in each group.

Table 4 is a summary of the involvement of the ethmoid and maxillary sinuses and of the ethmoid septums. (The frontal and sphenoid sinuses are excluded in this summary because of their low percentage of disease, and because when they were involved, there was always some pathologic condition in the ethmoid or maxillary sinuses.) The degree of involvement in these nasal sinuses was: moderate 36 per cent; moderately severe 15 per cent, and severe 6 per cent; this makes a total of 57 per cent with more than slight involvement. By adding twenty-nine other cases with pathologic changes in the septums, a grand total of eighty-six cases (86 per cent) is obtained. In other words, 86 per cent of these children with disease of the ears had signs of definite disease in their nasal sinuses. Without x-ray examination, only a few of the conditions could have been correctly diagnosed. There were five with condensing osteitis, nineteen with absorption of the septums, and forty-seven with edema of the septums, a total of seventy-one with pathologic changes in the septums. Adding to these fifteen other cases with definite involvement of the bony spaces of the sinuses, there is a total of eighty-six (86 per cent) with definite signs of past or present sinusitis. Some pathologic changes in the sinuses were present in all the other patients. All doubtful cases were not counted.

TABLE 3.—*Detailed Summary of the X-Ray Observations in the Nasal Sinuses*

No. of Cases	Diagnosis	Frontal	Ethmoid	Sphenoid	Maxillary	Ethmoid Septums: Condensing osteitis	Ethmoid Septums: Absorption	Ethmoid Septums: Edematous	Total Septums
5	Nonsuppurative otitis media	1 +++ 2 ++	1 +++ 2 ++ 2 +	1 +++	1 ++++ 1 +++ 1 ++ 2 +	0	2	2	= 4 abnormal
	Some involvement...	60%	100%	20%	100%				
	Moderate or severe..	60%	60%	20%	60%			80%	abnormal
37	Healed suppurative otitis media	1 +++ 5 ++ 8 + 4 abnormal.....	14 + ... 13 + ...	..... 1 ++ 8 + ...	2 ++++ 3 +++ 9 ++ 14 +	0	10	19	= 29 abnormal
	Some involvement...	49%	73%	24%	78%				
	Moderate or severe..	27%	38%	3%	32%			78%	abnormal
34	Recurrent suppurative otitis media	1 ++++ 2 +++ 7 ++ 12 +	1 ++++ 2 +++ 13 ++ 13 +	1 +++ 1 ++ 8 + ...	2 ++++ 3 +++ 14 ++ 10 +	4	6	13	= 23 abnormal
	Some involvement...	85%	85%	30%	86%				
	Moderate or severe..	30%	47%	0%	56%			68%	abnormal
13	Chronic suppurative otitis media	1 +++ 2 ++ 4 +	5 +++ 2 ++ 4 +	1 ++++ 2 ++ 3 +	2 +++ 5 ++ 4 +	1	1	5	= 7 abnormal
	Some involvement...	54%	85%	54%	92%				
	Moderate or severe..	22%	54%	31%	54%			54%	abnormal
11	Nerve	1 ++ 2 + 3 abnormal	2 ++ 5 + ...	4 + ...	3 +++ 2 ++ 3 +	0	0	8	= 8 abnormal
	Some involvement...	54%	63%	33%	73%				
	Moderate or severe..	36%	19%	None	45%			73%	abnormal
	Total moderate or severe involvement	31%	42%	7%	48%				
	Condensing, absorption or edematous								71 cases
	Others with severe involvement								15
	Total with sinusitis (pathology)								86%

TABLE 4.—*Summary of X-Ray Observations Showing the Involvement of the Ethmoid and Maxillary Sinuses and of the Ethmoid Septums*

Disease of the Ear	Lumen ++++	Lumen +++	Lumen ++		Septums: Other Cases with Absorption, Condensing, Edematous		Abnormal	Total
Nonsuppurative otitis media	1	1	1	= 3	+ 1	=	4	= 80%
Healed suppurative otitis media	2	3	14	= 19	+ 15	=	34	= 90%
Recurrent suppurative otitis media	2	4	15	= 21	+ 8	=	29	= 85%
Chronic suppurative otitis media	1	4	4	= 9	+ 2	=	11	= 85%
Nerve	0	3	2	= 5	+ 3	=	8	= 73%
Totals	6	+ 15	+ 36	= 57%	+ 29%	=	86	= 86%

Disease of the Ear	Septums Condensing osteitis, Absorption, Edema			Lumen		No. of Separate Abnormal Cases
Nonsuppurative otitis media	0	2	2	= 4	+ 0	= 4
Healed suppurative otitis media	0	10	19	= 29	+ 5	= 34
Recurrent suppurative otitis media	4	6	13	= 23	+ 6	= 29
Chronic suppurative otitis media	1	1	5	= 7	+ 4	= 11
Nerve	0	0	8	= 8	+ 0	= 8
Totals	5	+ 19	+ 47	= 71%	+ 15%	= 86%
	5	17	45	= 67%	in cases with histories of suppuration	

It is notable that the septums furnished the data for the greater number of abnormal conditions in the sinuses (71 per cent), in comparison with 57 per cent furnished by the sinus spaces (excluding slight or questionable shadows). If these are combined (septums and spaces), the areas appear to be diseased in 86 per cent of all the cases.

From this large percentage, it would seem logical to suspect that the inflammation of the sinuses was not wholly incidental, and that the middle ear, tube, mastoid and zygomatic cells (really adjacent sinus spaces of the nose) are rarely involved without concurrent or prior nasal disease. My data indicate that in at least 86 per cent of the cases of disease of the ear in children, the sinuses show definite involvement. This does not mean that the nose alone must be the cause of all the trouble in the ear any more than the ear alone must be the cause of all trouble in the nose. It indicates, however, that diseases of the ear and of the nose are closely associated, and that infection generally occurs simultaneously or precedes or follows in one or the other, at short time intervals, and that to cure or prevent disease in one, the other must be kept in mind.

I wish to stress especially the importance of sinus disease as a cause of recurrence and chronicity in suppurative otitis and progressive deafness therefrom. Chart 3 shows the effect of an acute congestion and earache (no discharge) on the hearing of a girl, aged 6 years, coincident with an exacerbation or reinfection in her nasal sinuses. It should be noted that this was one of the cases in which x-ray examination did not show even a moderate degree of involvement of any of the sinuses, or any marked pathologic change in the ethmoid septums; yet there was a sinusitis, with thickened membranes and the usual clinical picture. Many such faint x-ray observations compel the conclusion that the sinuses are more often inflamed than is realized. This picture is typical; it threatens marked progressive and permanent deafness. The condition is seldom appreciated, because it is not looked for.

In my experience, progressive deafness with so-called recurrent otitis of the middle ear, occurs more often than does progressive deafness without otitis, and in many cases in which the condition is diagnosed as otosclerosis, a history of inflammation in or about the middle ear may be obtained if persistent questioning is focused on this point. I have little doubt but that true otosclerosis may be caused in part by inflammation in the sinus spaces in and near the ear. The otosclerosis is the terminal process of a prior disease. I make it a habit to ask the children and their parents questions like these: Did you ever have pain in your ear? When did you have earache last? Which ear? How long? Did your ear ever run? How many times? Did mother put drops in your ear? Did she wash the ear with hot water or syringe it out?

When you went in bathing, did your ears stop up? How long? Did they hurt after bathing? Did they run?

These questions often elicit positive histories of earache. Earache in children usually means tubal and middle ear inflammation. Earaches in infants and little children are naturally soon forgotten by the sufferer, and often sooner by the mother or nurse. Frequently the earache and

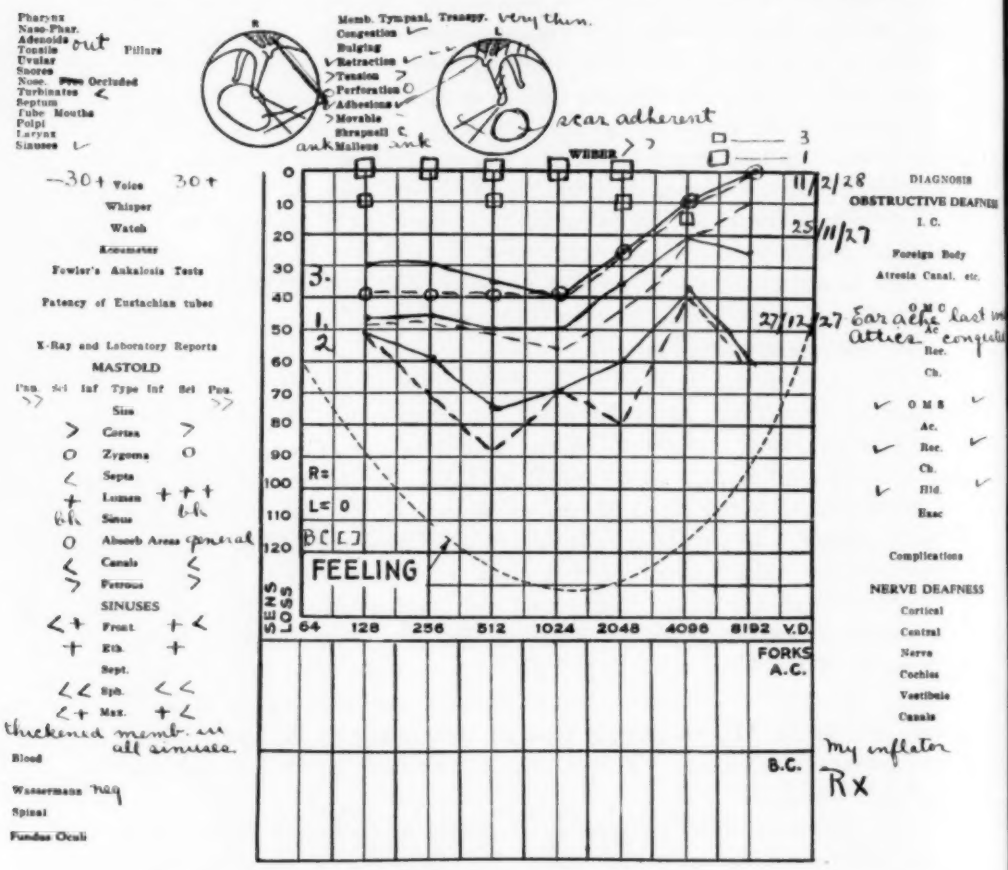

Chart 3.—Effect of acute otitis (nonsuppurative) from exacerbation of a chronic sinusitis.

the inflammation accompanying it are not recognized. In the pneumonias of infancy it is known that more than 95 per cent of the cases that come to autopsy show suppurative otitis. In thirty-two cases of lobar pneumonia in little children (at St. Mary's Hospital for Children) during February and March, 1928, I found eleven cases of acute disease of the ear with suppuration. This is 35 per cent, but it is probable that several were missed, and that at least 40 per cent would be more

nearly accurate. This is the reason why I have included the observations of cases of pneumonia, with repeated colds.

In table 5 are given the data in eighty-four cases with present or past suppuration, with involvement of the ethmoid and maxillary sinuses, and with pathologic changes in the ethmoid septum. This indicates that the ethmoid cells are involved directly as the chronicity of the inflammation of the ear, and the antrums much more in recurrent and chronic suppurations of the ear, than in healed suppurations. These conditions of chronicity often interchange, the chronic becoming recurrent or healed, the recurrent becoming chronic or healed, the healed becoming recurrent or chronic, and so on; nevertheless, the x-ray observations are illuminating.

The ethmoid septums show pathologic changes inversely as the chronicity of the suppuration. This inverse ratio is marked, and indicates that in these cases there is an inverse ratio between the pathologic changes in the mastoid septums, and those in the ethmoid septums, and

TABLE 5.—*Summary of Ethmoid and Maxillary, and Ethmoid Septums Involvement, in Eighty-Four Cases, with Present or Past Suppuration of the Ears*

	No. of Cases	Ethmoid	Maxillary	Ethmoid Septums	Condensing	Absorption	Edematous
Healed suppurative otitis media.....	37	38%	32%	78%	0	27%	51%
Recurrent suppurative otitis media..	34	47%	50%	68%	12%	18%	38%
Chronic suppurative otitis media....	13	54%	54%	54%	8%	8%	38%
	84						

that the course of the disease is usually different in each. In the healed cases condensing osteitis was not demonstrable, whereas in the recurrent cases it was 12 per cent, and in the cases of chronically running ears it was 8 per cent. Condensing osteitis is a terminal stage of healing in inflammation of the bone, similar to atrophy and fibrosis in the mucous membranes. It occurs only after long continued or repeated irritations. The walls of the ethmoid cells are covered with mucoperiosteum, and these partake of changes similar in a way to those in the more typical mucous membranes over the turbinates. Hence, when the blood supply is finally reduced after prolonged or repeated inflammation, a condensing osteitis results. The presence of condensing osteitis indicates long or recurrent obliterating pathologic changes. If the inflammation is transient or of low grade, osteitis may not be demonstrable.

Absorption occurred in twenty-seven of the healed cases; it occurred in 18 per cent of the recurrent, and in 8 per cent of the cases of chronic suppuration in the ear. Edema occurred in 51 per cent of the healed, and in only 38 per cent of the recurrent and chronic cases. In many of the cases noted under (ab), there was also edema of the

septums. In a few of the recurrent and chronic cases, besides the osteitis, there was also edema or absorption, or both. In the healed cases, osteitis was not found. Absorption and edema occurred in indirect proportion to the chronicity of the discharge from the ears. Edema was, then, more often present in the healed cases than in any others in this group. The presence of edema may be a constant menace, a condition that may be aggravated by many inciting causes. It may at any time light up a local sinusitis or a pansinusitis, involving the middle ear in infection, and endangering the inner ear or nerve through infection or toxemia or both.

In the healed cases there is the smallest percentage of involvement of the ethmoid and maxillary sinuses (38 and 32 per cent) and the largest amount of absorption and edema (27 and 51 per cent, a total of 78 per cent). These figures suggest that the nasal sinusitis often clears up, leaving visible only absorption, condensing osteitis or edema to indicate the prior trouble, and that when it does not clear up, the probability of recurrence or chronicity of suppuration in the ear is greatest. If the sinusitis clears up, leaving infection pocketed within the ear spaces, the ears may become a menace to the sinuses, and thus establish a vicious circle within the spaces in the ear and nose.

I have discussed particularly the occurrence of nasal sinusitis in the eighty-four cases of suppurative disease of the ears. In tables 1, 3 and 4 is given also the incidence of sinusitis with nerve deafness. In this diagnostic group (eleven cases), there were six patients with discharging ears or earache; this may account in part for the high ratio of sinus involvement, but it should be noted that the mastoids showed abnormal septums or lumens in only four cases, and that in only one case were there any absorption areas in the mastoid. The incidence of positive sinusitis was, with nerve deafness: frontal, 36 per cent; ethmoid, 19 per cent; sphenoid, none; maxillary, 45 per cent; and ethmoid septums: condensing, 0; absorption, 0 and edematous 8, or 73 per cent.

The frontal sinuses were involved proportionately more than in any of the other diseased groups (except in cases of nonsuppurative otitis media). The drainage from the frontal sinuses is deposited in the middle meatus further from the nasopharynx and eustachian tubes than is the drainage from any of the other sinuses, which may account for the relative lack of symptoms of inflammation of the ears in these two groups. The ethmoid cells were involved proportionately less often than in any of the other disease groups. The sphenoids did not show any pathologic changes. The maxillary antrums showed less involvement than in any of the groups, except in the cases of healed suppuration. The ethmoid septums did not show condensing osteitis or absorption, but in eight cases they were edematous. In five cases with edema there was also marked involvement of the maxillary antrum, and in one of

these five the ethmoid cells were also moderately involved. In the remaining three cases with edema of the septums, other pathologic conditions in the sinus were not observed. These proportional variations were generally similar to those in nonsuppurating or healed cases, especially so far as the ethmoid septums were concerned, the septums being pathologic (edematous) in 73 per cent of the cases of nerve deafness, in 80 per cent of the nonsuppurative cases and in 78 per cent of the healed suppurative cases. All these percentages are higher than those found in the cases of chronic or recurrent suppurations, as shown in the tables.

With the exception of two cases of nerve deafness, and of one chronic, five recurrent and nine cases of healed suppuration, every involvement of the ethmoid and maxillary sinuses in these children was in some degree concurrent, and all but one or two cases in each diagnostic classification were bilateral, with the exception of the cases of healed suppuration of the ear, of which 50 per cent were unilateral.

An attempt was made to establish a control by examining many normal subjects. It was found that hearing may be an average normal in both ears when the sinuses show distinct and sometimes marked pathologic changes, but that in such instances histories and signs of past suppuration in the ear are regularly present. Three hundred and sixty-one of 775 children tested by the audiometer, who showed average normal hearing, gave past histories of otitis media.

SUMMARY AND CONCLUSIONS

1. Complete histories, tests and stereoroentgenograms of the skull give data, otherwise unobtainable, for the study and treatment of diseases of the ear.

2. The x-ray examination of the temporal bone, except for the pathologic changes in the mastoid, is not so important as stereoroentgenographic examination of the nasal sinuses.

3. Fifty-seven per cent (of 100 cases in children) showed moderate or severe involvement of the nasal sinus spaces.

4. Seventy-one per cent showed pathologic changes in the ethmoid septums.

5. Eighty-six per cent showed positive pathologic changes in the sinuses.

6. The chronicity of the suppuration in the ear was directly proportional to the involvement of the sinus spaces, and indirectly proportional to the pathologic changes in the ethmoid septums.

7. Diseases of the nasal sinuses, and of the sinuses of the ear, are intimately associated, and prevention, alleviation and cure of one necessitates the prevention, alleviation and cure of the other. Recurrent

inflammation in one is caused by inflammation in the other, just as sinusitis in one nasal sinus may occur or recur as a result of infection from one of the other nasal sinuses.

8. There was no suspicion of a present or past suppuration in the ears, in only four cases (4 per cent). In no case were the nasal sinuses entirely normal. This means that in practically every one of these children there has been inflammation not only in the ears, but also in the nasal sinuses.

9. The coexistence of otitis and active or latent sinus infection is not coincidental.

114 East 54th Street.

GRADENIGO'S SYNDROME *

SAMUEL D. GREENFIELD, M.D.
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The advent of palsy of the sixth nerve, parietotemporal or supra-orbital pain occurring in connection with an acute suppurative otitis media has long been a well established clinical entity. According to the clinical manifestations, three groups of cases are described:

The first group includes patients who have an acute otitic infection, parietotemporal, supra-orbital or retrobulbar pain and a paresis of the sixth nerve. The majority of these patients recover spontaneously.

The second group includes patients who present all of the conditions mentioned, and in addition have involvement of the second, third and fourth nerves. Most of these patients recover.

The third group includes patients who present the symptoms of either of the previous groups, but in whom the condition has a fatal termination as a result of a diffuse leptomeningitis.

The pathologic process of the so-called Gradenigo's syndrome exists in the form of a circumscribed serous leptomeningitis, which originates from an involvement of the cells in the petrous pyramid. The infection gains access to this area through one or more of several routes.

In cases in which there are definite evidences of infection and necrosis of the mastoid, the petrous tip becomes involved as a result of direct extension of the suppurative process. This is more apt to occur when there is an unusual pneumatization into the apex of the petrous bone. The infection localizes here and produces an osteomyelitis of the tip of the bone. Extension to the overlying dura follows, with the subsequent development of a serous meningitis. Owing to edema of the adjacent tissues, pressure is exerted on the sixth nerve as it courses over the superior surface of the petrous tip. In a similar manner, there is an involvement of the second, third and fourth nerves. Owing to the proximity of the gasserian ganglion, which is located on the anterior surface of the bone, pressure on the ganglion is evidenced by the temporoparietal, supra-orbital or retrobulbar pain.

When no clinical evidence of the involvement of the mastoid is apparent, the propagation of the infection from the middle ear to the petrous tip is along preexisting anatomic pathways. In this group are included: (1) cases in which the infection extends from the tympanum below the labyrinth and internal auditory meatus to the petrous tip; (2) cases in which the process extends by way of the carotid canal, access to which is obtained by erosion of the bone or of the tympanic foramina

* Submitted for publication, Sept. 28, 1928.

which transmit carotid branches of the tympanic plexus, and (3) cases in which the suppuration follows through a layer of cells which extend along the eustachian tube from the middle ear to the apex of the petrous bone. It seems most likely that the last route is the one which the infection follows in the majority of cases.

It is the concensus of opinion, as drawn from the cases reported in the literature, that in most instances definite evidence of involvement of the mastoid is present. Furthermore, it seems to appear that in these cases the mastoiditis is of a more severe type and the necrosis unusually extensive. In the case that I am reporting such observations were made at operation. The zygoma was completely broken down. This structure extended far forward, beyond the auditory canal into the zygomatic root of the temporal bone. The mastoid body was extremely large for a child aged 6, and was unusually pneumatic.

It is reasonable to understand that the group into which the case falls is determined by the severity of the infection, the ability of the patient to wall off and localize the infection and the extent to which the adjacent structures are involved. A milder infection and one that the patient is able to localize will involve only the sixth nerve. When the process is more severe or the resistance such as to permit of a greater spread of the infection, there will be involvement of the second, third or fourth nerves in addition. And lastly, when the invasion is severe and localization does not take place, the process goes on to the development of a diffuse meningitis.

It is interesting to note that the appearance of the pain and the palsy vary in their relation to the course of the otitic and mastoid condition. The pain may develop during the middle ear stage; on the other hand, it may come on during the height of the mastoid infection, or it may be noted only after the operation on the mastoid, either immediately or several days later. Lastly, the syndrome may develop weeks after the operation, when the mastoid wound is almost healed. In all the cases, however, a notable feature is the persistence of a profuse aural discharge.

The case that I am reporting is one in which the outstanding features were the appearance of the palsy of the sixth nerve, thirty-three days after the operation on the mastoid had been performed. The mastoid wound was almost completely healed. In this case, the pain was mainly retrobulbar and was of a burning nature. The palsy lasted three weeks and finally cleared up.

REPORT OF CASE

History.—R. C., a girl, aged 6 years, was referred to me on March 8, 1928. Three weeks prior to examination she had severe grip, in the course of which she developed an acute suppurative otitis media. The drum ruptured spontaneously twenty-four hours after the onset of the otitis. There was an abatement of the acute pain, but the discharge continued to be profuse up to the time of

examination. The patient was restless and had a rise in temperature in the evenings, ranging from normal to 101 F. The mastoid was moderately tender over the tip and antrum; the discharge was thick and profuse; the posterior wall of the canal showed a moderate drooping.

The patient was admitted to the Beth Moses Hospital on March 11, the day after I performed a simple mastoidectomy. As I stated before, the mastoid was large, of a pneumatic type and completely broken down. There was an extensive zygoma, which I took particular care to clean out thoroughly. A small area of dura was uncovered over the tegmen antri. It was subsequently reported that the pus from the mastoid showed *Streptococcus pyogenes.*

Course.—The day following the operation, the temperature of the patient rose to 104 F. and then gradually declined, but never reached normal during her entire stay in the hospital. She complained of postauricular pain for several days after the operation, but not more than is usually noted.

On March 15, the first complete dressing was done. The middle ear discharged profusely, but the posterior wound appeared clean.

During the next few days, the patient improved rapidly. Her temperature never rose above 100 F., and her general condition was excellent. On March 19, eight days after the operation had been performed, I permitted the patient to leave the hospital. She then continued in the usual postoperative course. She came to my office on alternate days for dressings.

From March 21 to April 2, nothing unusual was noted, with the exception that she ran a low grade fever in the evenings. On several occasions, it reached as high as 101 F. Her general condition was not as good as it had been in the hospital. Her appetite was poor, and she preferred to remain in bed and rest rather than to play about as she was accustomed to do previous to the operation. On April 2, she spent a restless night complaining of severe parietotemporal pain and a burning sensation behind the right eye. She was an intelligent and precocious child, and was accurate in describing her symptoms.

On April 3, I saw her again and found that she was suffering severely. She complained of photophobia and headache. The mastoid wound was almost healed, except for a small sinus at the lower end of the incision. The middle ear discharged moderately. The temperature was 102 F.; the pulse rate, 122, and the respirations, 28. There was no evidence of meningitis. The urine was normal, and a general physical examination did not disclose anything to explain the pyrexia.

The patient was readmitted to the Beth Moses Hospital on April 9, 1928, thirty days after the original operation on the mastoid.

On April 10, a pediatric examination did not disclose anything. The patient was pale and asthenic. There was no evidence of involvement of the intracranial nerves. Examination of the blood showed: red blood cells, 3,000,000; hemoglobin, 56 per cent; white blood cells, 10,600, and polymorphonuclears, 62 per cent. The report on the urinalysis was negative.

On April 11, the temperature was 101 F.; the pulse rate, 100, and respiration, 24. The patient was very uncomfortable. She complained of severe pain in the right side of the head. Neurologic examination by the attending neurologist did not show any evidence of involvement of the central nervous system or its coverings.

On April 12, the patient complained of severe retrobulbar pain. She cried continuously and was quieted only after a hypodermic injection of morphine sulphate. The temperature on that day reached 102 F.; the pulse rate, 109, and the respirations, 28.

On April 13, the patient complained of double vision. There was a definite internal strabismus of the right eye. The pupils reacted to light and in accommodation. Examination of the fundus showed a slight blurring of the disk.

During the three days of April 15, 16 and 17, the pain in the head and the burning pain behind the right eye seemed to abate somewhat. The question of lumbar puncture came up. I felt that under the circumstances, the condition was a localized meningitis, and that any procedure that would be apt to disturb the walling off process should not be employed. I therefore advised against lumbar puncture, feeling that even if it were carried out with the utmost care, the information obtained therefrom would not aid materially in the diagnosis or the treatment.

On April 18, the temperature reached 102 F.; the pulse rate, 122, and the respirations, 30. The mastoid was dressed; the middle ear continued to discharge profusely, and the posterior wound was secreting considerably. The pain, however, seemed to be much less than on previous days. The diplopia was still present, although it seemed that the external rectus muscle of the right eye was regaining some of its functions.

On April 19, 20 and 21, the patient's condition was much improved. She appeared more cheerful during the day, although at night the pain was still annoying. During these three days, the temperature never rose above 100.

On April 22, 23 and 24, the right eye seemed to move out further on extreme abduction. The report of the ophthalmologist was that there was a marked improvement of the function of the external rectus. The patient's general condition was much better. The temperature reached normal. Diplopia was noted only when she looked to the extreme right.

The patient's condition continued to improve daily (April 25, 26 and 27). The temperature remained normal, and the diplopia disturbed the patient only on extreme abduction. The eyeball moved outward fairly well, showing that the rectus muscle was rapidly regaining its function.

On April 30, the patient was permitted out of bed. The appetite had improved considerably, and she had gained weight. The mastoid wound was almost healed, but the middle ear discharged slightly. The diplopia had entirely disappeared. On May 5, the patient was discharged from the hospital, well on the road to recovery.

CONCLUSIONS

This case presents several features of special interest.

1. The diplopia did not appear until thirty-three days after the operation on the mastoid, which shows that a considerable period may elapse before the process extends internally to affect the abducens nerve.

2. The mastoid wound was practically healed when the paralysis developed.

3. The patient complained of a type of pain not usually described as associated with a Gradenigo's syndrome, e.g., retrobulbar pain. This pain persisted for more than two weeks.

4. A significant fact is the profuse aural discharge which continued throughout the course of the disease.

169 New York Avenue.

THE BONY LABYRINTH OF THE NEW-BORN INFANT AND OF THE ADULT

A COMPARATIVE STUDY

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MONTREAL

In a comparison of the ear of a new-born child with that of an adult, it is found that certain parts differ greatly in the two cases, while others are nearly identical, for the growth of the various parts of the ear is not uniform, some not being fully formed until after puberty, while others attain their adult size and form by the end of fetal life. To the latter category belong the internal ear, the tympanic cavity with its auditory ossicles and the mastoid antrum; to the former, the external auditory meatus, the eustachian tube and the mastoid portion of the temporal bone. With this in mind, my purpose in this paper is to show by a comparison of figures the actual measurements of the various parts of the bony labyrinth at different ages.

In recent years, although the physiology and histology of the internal ear in the human being have been worked out, one is apt to forget that the anatomy of the part has been known for a long time. It is difficult to realize that the labyrinth was recognized and described in detail over two centuries ago, as is shown in an account found in an old English edition by James Keill, M.D., entitled, "The Anatomy of the Humane Body," printed in London in the year 1710.[1] The description is

* Submitted for publication, Aug. 22, 1928.

1. Keill, James: The Anatomy of the Humane Body, London, Printed for R. Smith at the Bible under the Royal Exchange, Cowhill, 1710, p. 92.

"The Vestibule is a Cavity in the Os Petrosum, behind the Fenestra Ovalis; it is above two Lines broad, as much long, and a Line and a half high. In it open in the Semicircular Pipes of the Labyrinth. The upper turning of the Cochlea, and the Auditory Nerve at five small Holes. The Labyrinth is made of three Semicircular Pipes above half a Line wide, excavated in the Os Petrosum; they open by five Orifices into the Vestibulum. That which is called the Superior Pipe, which is generally about 5 or 6 Lines long, joins one of its Extremities with one of the Extremities of that which is called the Inferior Pipe (which is about six or seven Lines long), and these two Extremities open by one Orifice, but the middle Pipe opens at each end by itself into the Vestibulum. This is about four or five Lines long.

"The Cochlea is a Cavity of the Ear in front of the Vestibulum; it resembles a Snail's Shell. Its Canal, which winds in a Spiral Line, is divided in two, the Upper and the Lower, by a thin Lamina Spiralis, of which that part next the Axis is bony, but extreamly brittle, and that next the outer Shell is Membranous,

remarkably accurate, considering the fact that it must have been worked out entirely by dissection.

Scientific investigation of the internal ear may now be carried out by three methods, according to Albert Gray, none of which proves entirely satisfactory: corrosion casts, macroscopic specimens and microscopic sections.

"Corrosion preparations show the bony cavity, not the membranous structures; fragments obtained by dissection lose their relative position; and microscopic sections, while revealing the finer details, destroy the picture of the whole organ." [2]

With this in view corrosion casts were made of twelve temporal bones, taken from persons of presumably normal hearing and not suffering from any condition which could be associated with the labyrinth. Six were taken from infants who died within a few days

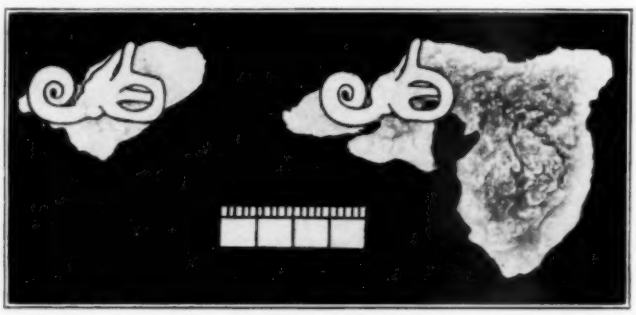

Fig. 1.—Two right labyrinths with a scale in millimeters for comparative measurements. The labyrinth to the left is that of a new-born infant, while that on the right is from a young adult. The extreme length of the labyrinth from the vertex of the posterior canal to the innermost part of the cochlea is practically identical in the two specimens. Although the external transverse diameter of the posterior canal is a little shorter than usual in both cases, practically all the other measurements agree with the mean figures of the tables.

after birth in a maternity hospital, and six were from adults of both sexes whose ages varied from 20 to 63.

It is well known that the labyrinth of a human being is not of uniform size in different persons, but the extent of the variations is not commonly recognized.

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appearing to be only made of the Auditory Nerve. The upper Canal opens into the Tympanum, and the lower into the Vestibulum. This is narrower than that, especially towards the Basis of the Cochlea, where each is about a Line wide, and the Basis itself is about four Lines in Diameter."

2. Gray, A. A.: Anatomical Notes Upon the Membranous Labyrinth of Man and of the Seal, J. Anat. & Physiol. **39**:349, 1905.

The work about to be described was accomplished by preparing metallic casts of the labyrinths of human beings and tabulating the measurements. As mentioned previously, this method is not ideal, as the bony cavity is shown, the membranous structures being destroyed, but as the same measurements were taken in each specimen a relative comparison is obtained.

As stated previously, the mastoid antrum is developed at birth, whereas the spread and distribution of the mastoid cells is not attained

TABLE 1.—*Observations Made in the Labyrinths of Infants*

	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
Extreme length of the labyrinth from the vertex of the posterior canal to the innermost part of the cochlea	18.25	18.75	18.50	18.50	19.00	18.00	18.50
Diameter of the lowest whorl of the cochlea at the beginning of the first turn	8.25	8.50	8.00	8.25	8.75	9.00	8.46
Diameter of the second whorl of the cochlea	5.25	5.00	5.25	4.75	5.00	5.00	5.04
Diameter of the tube of the cochlea just in front of the round window	2.25	2.50	2.75	2.50	2.50	2.50	2.50
Diameter of the vestibule just above the oval window	4.00	4.00	3.75	3.75	3.50	3.50	3.75
Transverse diameter of the superior semicircular canal from limb to limb: internal	5.00	5.25	4.25	5.50	4.75	5.25	5.00
Transverse diameter of the superior semicircular canal from limb to limb: external	8.50	9.00	8.75	8.75	8.50	8.75	8.71
Height of the superior semicircular canal from the vestibule	4.75	5.75	6.00	5.00	5.25	4.25	5.16
Diameter of the superior semicircular canal itself at the vertex	1.50	1.25	1.50	1.75	1.50	1.50	1.50
Length of the superior canal	11.25	11.50	10.50	10.75	11.75	10.25	11.00
Transverse diameter of the posterior semicircular canal from limb to limb: internal	3.75	4.25	5.00	4.00	5.75	4.75	4.60
Transverse diameter of the posterior semicircular canal from limb to limb: external	7.50	8.50	8.00	7.50	8.75	8.75	8.16
Height of the posterior semicircular canal from the vestibule	4.25	5.25	5.25	5.00	5.00	4.50	4.87
Diameter of the posterior semicircular canal itself at the vertex	1.75	1.75	2.00	1.75	2.00	2.00	1.87
Length of the posterior canal	11.75	12.00	11.75	11.50	12.25	11.25	11.75
Transverse diameter of the external semicircular canal from limb to limb: internal	2.75	2.25	3.50	3.25	2.50	3.00	3.04
Transverse diameter of the external semicircular canal from limb to limb: external	6.50	7.25	7.50	7.50	7.75	6.25	7.12
Height of the external semicircular canal from the vestibule	3.00	3.25	3.75	3.25	3.75	2.75	3.29
Diameter of the external semicircular canal itself at the vertex	1.75	1.75	2.00	1.75	2.00	1.75	1.83
Length of the external canal	8.50	8.00	8.25	8.50	8.50	8.25	8.33

until after puberty. This is particularly well seen in the adult specimen, the large gray mass of metal showing the extent of the cells and their communication with one another.

The tables follow closely the scheme outlined by Albert A. Gray of Glasgow in his masterful work: "The Labyrinth of Animals." [3]

As the accompanying tables show the extent of the variations, little explanation is necessary. However, a few must be mentioned, as not one of the structures has a constant size. The total length of the labyrinth from its outermost point on the vertex of the posterior canal to its innermost point on the lowest whorl of the cochlea varies but slightly.

3. Gray, A. A.: The Labyrinth of Animals, London, J. & A. Churchill, 1907.

In the twelve labyrinths examined, including both those of infants and those of adults, the variation was but 1 mm. out of a mean total of about 18.5 mm. The average length of the labyrinth in the infant in this series was 18.5 mm., while that of the adult was 18.46 mm. The diameter of the lowest whorl of the cochlea was 8.46 mm. in the infant, as compared to 8.62 mm. in the adult, and of the second whorl, 5.04 mm. as compared to 5.08 mm.

TABLE 2.—*Observations Made in the Labyrinths of Adults*

	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
Extreme length of the labyrinth from the vertex of the posterior canal to the innermost part of the cochlea	18.25	18.00	18.50	19.00	19.00	18.00	18.46
Diameter of the lowest whorl of the cochlea at the beginning of the first turn	8.00	9.00	8.50	9.00	8.75	8.50	8.62
Diameter of the second whorl of the cochlea	4.75	5.00	5.00	5.25	5.25	5.25	5.08
Diameter of the tube of the cochlea just in front of the round window	2.25	2.50	2.50	2.75	2.50	2.75	2.54
Diameter of the vestibule just above the oval window	3.50	3.50	4.00	4.00	4.00	3.75	3.80
Transverse diameter of the superior semicircular canal from limb to limb: internal	4.25	4.75	5.25	5.25	5.50	4.75	4.95
Transverse diameter of the superior semicircular canal from limb to limb: external	8.50	8.75	9.00	8.75	9.00	8.75	8.80
Height of the superior semicircular canal from the vestibule	4.75	4.75	6.00	4.75	5.50	4.50	5.04
Diameter of the superior semicircular canal itself at the vertex	1.50	1.50	1.50	1.75	1.25	1.50	1.50
Length of the superior canal	12.50	12.25	11.75	11.50	11.75	12.25	12.00
Transverse diameter of the posterior semicircular canal from limb to limb: internal	4.00	4.25	5.25	5.25	5.00	4.75	4.75
Transverse diameter of the posterior semicircular canal from limb to limb: external	8.00	8.00	8.25	8.50	8.75	7.75	8.20
Height of the posterior semicircular canal from the vestibule	4.00	4.25	5.75	5.75	5.00	4.25	4.83
Diameter of the posterior semicircular canal itself at the vertex	2.00	2.00	1.75	1.75	1.75	2.00	1.87
Length of the posterior canal	13.75	13.00	12.75	13.25	13.00	13.50	13.20
Transverse diameter of the external semicircular canal from limb to limb: internal	2.50	2.75	3.00	3.50	3.25	3.00	3.00
Transverse diameter of the external semicircular canal from limb to limb: external	6.50	6.50	7.50	7.75	7.00	7.25	7.08
Height of external semicircular canal from the vestibule	3.00	3.25	3.25	3.25	3.75	3.00	3.25
Diameter of the external semicircular canal itself at the vertex	1.75	1.75	1.75	1.75	2.00	2.00	1.83
Length of external canal	11.25	10.50	11.25	11.00	11.25	11.00	11.04

The diameter of the tube of the cochlea just in front of the round window is practically identical in the two tables, 2.5 mm. in the newborn infant and 2.54 mm. in the adult.

The measurements of the canals themselves are interesting. Although the posterior canal is the longest and the external canal the shortest in human beings, this rule does not hold true for all mammals. In the seal, for instance, the superior canal is easily the longest, and the posterior canal the shortest.

The posterior canal, although actually longer from end to end than the superior canal, has a shorter transverse diameter measured from limb to limb. An arch is formed by the superior canal which is wide and shallow, while that of the posterior canal is long and narrow. The diameter of the three canals at the vertex of each is fairly constant,

that of the posterior canal being the greatest and that of the superior being the smallest.

As mentioned previously, according to the tables, the posterior semicircular canal is the longest both in the new-born infant and in the adult, and the external canal is by far the shortest.

Although this is true, the three canals do not grow to the same extent from birth to adult life. The increase in length of the canals is greatest in the external canal,[4] nearly 3 mm. (that is, from 8.33 to 11.04 mm.) and least in the superior canal, exactly 1 mm. in this series (from 11 to 12 mm.). The posterior canals also show growth (from 11.75 to 13.2 mm.) an increase of 1.45 mm.

According to Hyrtl, "the external canal turns off downward so that the line of direction of the canal becomes wavy." [5]

One part of the labyrinth alone may show a considerable variation, that is, large canals may be accompanied by a small cochlea, and vice versa. Also, a large lower whorl may be associated with a small second whorl.

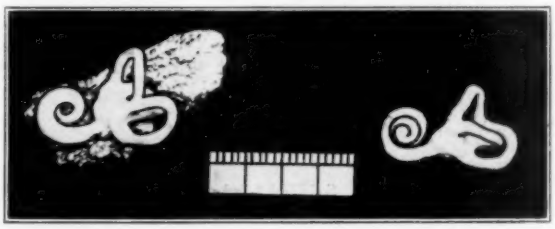

Fig. 2.—A large sized labyrinth of an infant on the left and a small one from an adult on the right. Comparative measurements cannot be obtained from the illustration, as the labyrinth from the infant is shown from the right side and that from the adult, from the left side. In the pouring of the molten metal, the funnel was placed in the external canal of the specimen to the left, so that all the cells of the temporal bone were filled as well as the inner ear. For the sake of clearness, as will be seen later, it was deemed advisable in the case of the adult to make a cast of the labyrinth alone to show the external semicircular canal. This was done by means of a long narrow funnel fixed in the oval window. As the inner ear is a closed system for purposes of this kind, just the cochlea, vestibule and semicircular canals filled with lead, leaving the rest of the bone free.

The canals in the human being are not regularly curved as compared to those, for instance, of the monkey, horse or cow.

The labyrinth from the infant in figure 1 brings out this point. Quite an angle is seen at the upper part of the posterior canal, and the same thing is seen to a less degree in figure 2.

4. Alexander, G.: Arb. a. d. Anat. Inst. **19**:571, 1902.
5. Hyrtl: Prague, 1845.

The plane of each of the three canals throughout its course is not the same in human beings; that is, the canals seem to be slightly twisted or rolled on their axes. This is well shown, especially in the case of the superior canal, in all the specimens.

Finally, the relation of the cochlea, as a whole, to the first turn must be considered, as there is a marked difference between that in the very young child and that in the grown-up.

It has been known for a long time that "the beginning of the first turn of the cochlea does not touch the end of the first turn in the new-born infant." As the child grows, this space becomes narrowed down, until in the adult it has, as a rule, practically disappeared.

This well-marked space is easily seen in the labyrinth of the infant (fig. 2), and the specimen was tilted purposely to demonstrate the size of the cleft between the first and second turn of the cochlea.

As mentioned before, this space was not apparent to the same extent in the specimens. In a few of the specimens, a small chink was left, while the great majority showed this space to be almost obliterated. Even in the casts of labyrinths from adults, in which a narrow slit could be seen between the first and second turn of the cochlea, the space was perceptibly smaller than in any of the labyrinths from infants.

Although this point is of interest theoretically, it is without practical value, as far as can be ascertained.

SUMMARY

1. The bony labyrinth of the new-born infant is practically the same size as that of the adult.

2. There is a slight increase in size in some of the measurements, owing to growth, which is most marked in the semicircular canals.

3. The increase in length of the canals is greatest in the external, less in the posterior, and least in the superior canal.

4. The posterior semicircular canal is the longest and the external canal the shortest in both the new-born infant and the adult.

5. The diameter of the posterior canal itself at the vertex is the greatest, and that of the superior canal the least.

6. A small cochlea may be associated with large canals or a large cochlea with small canals.

7. The semicircular canals in the human are not regularly curved but show at times definite angles, which are sometimes well seen in the posterior canal.

8. Finally, the plane of each of the three canals is not the same throughout its course. Each canal seems to be twisted on its axis, this condition being most marked in the superior canal.

1390 Sherbrooke Street, West.

A COMPARISON OF THE OUTLINES OF THE FRONTAL SINUS IN VIVO

AS SHOWN BY TRANSILLUMINATION AND THE ROENTGEN RAYS *

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AND
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This brief communication represents an attempt to render slightly more accurate the estimation concerning the frontal sinuses at office examination.

In the study of disease of the paranasal sinuses, resort is usually had to two extranasal methods of examination: by transillumination and by roentgenograms. Only one of these procedures, the making of roentgenograms, is applicable to the posterior sinuses, but in an investigation of the anterior group, the frontal and the maxillary, both methods are available. It is generally agreed that neither method gives information of 100 per cent definitive value, on account of the many variables which must be considered before a conclusion is reached. Among these, particularly, should be mentioned variation in the size and shape of the sinuses themselves, in the thickness of their walls, in the size of the turbinals, in the straightness and thickness of the nasal septum and in the thickness of the soft tissue of the face. In addition, all realize that in the very young the small size of the frontal and maxillary sinuses causes transillumination to be a most uninstructive performance, a situation increased by the clouding presence of the unerupted permanent teeth.

It is hardly necessary to dilate on the effect produced by large turbinals on transillumination of the maxillary sinuses. All have noted how much more clearly one of these sinuses allows light to penetrate after an inferior or middle turbinectomy or an ethmoidectomy has been performed, in cases of atrophic catarrh or in very old persons. Likewise, a notably less clear passage of light through the maxilla, especially in the portion just lateral to the nose, is observed on the side toward which a markedly deflected septum bends. So constant is this observa-

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* From the Department of Otolaryngology of the University of Pennsylvania.
* Read before the Section of Otology and Laryngology of the College of Physicians of Philadelphia, Oct. 17, 1928.

Fig. 1.—Centrally situated sinuses. The transillumination outline accurately parallels the true outline.

Fig. 2.—Broad, moderately high sinuses. The transillumination outline parallels the true outline, even at the lateral portions of the sinuses.

tion that it often is possible to suspect a deviated septum by transillumination alone, and then to find this condition present on nasal examination.

On the other hand, it so frequently is observed that the frontal sinuses appear to be larger under transillumination than they proved to be when the roentgenograms were taken, or the sinuses were opened from the front, that we have endeavored to find out quantitatively how much difference there really is.

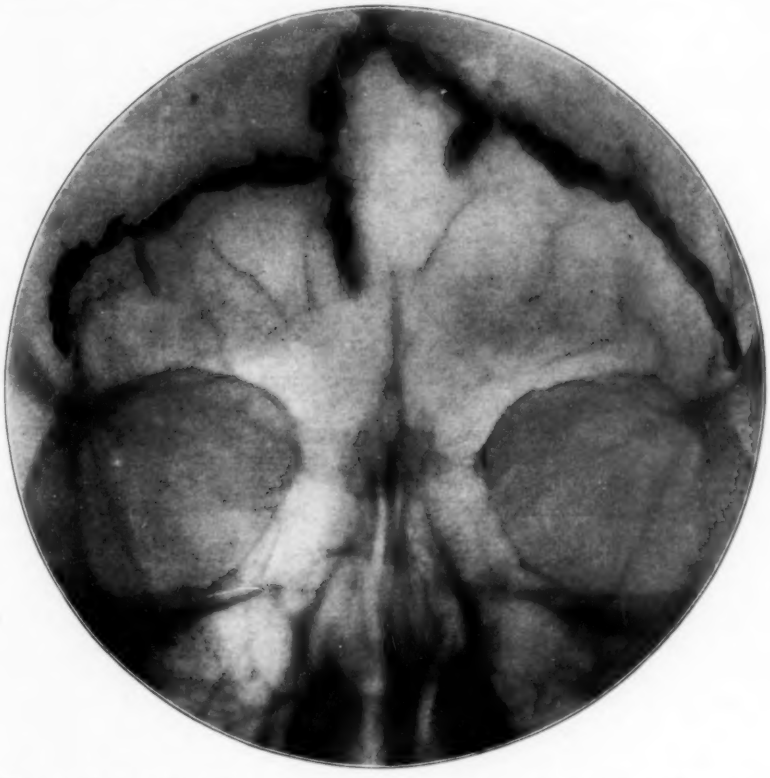

Fig. 3.—Broad, high and asymmetrical sinuses. Some of the septums shown by the roentgen rays are shown also by transillumination.

TECHNIC

We selected a small group of medical students and subjected their frontal sinuses to transillumination, placing the bulb at the usual place, the upper inner angle of the orbit. Then the apparent upper margin of the sinus was outlined on the skin with a small brush dipped in an opaque paint. The lateral margin was frequently so vaguely defined that it was impossible to locate it with any degree of accuracy; therefore, no

constant attempt was made to indicate it. After the painting, the patients were taken to the x-ray laboratory, and pictures were made by Dr. E. P. Pendergrass.

RESULTS

The result was interesting and is shown in three instances in the accompanying illustrations (figs. 1, 2 and 3). The frontal sinuses were decidedly smaller than they appeared to be on transillumination, and, on an average, extended up into the frontal bone from ½ to ¾ inches (1.27 to 1.9 cm.) less high than transillumination seemed to indicate.

These observations are, of course, purely anatomic, and their only justification is that what size to figure on can be accurately pre-estimated. The practical value of these observations only time and experience will show. They show, however, that the frontal sinuses really are smaller than transillumination indicates; and that to conceive of them in their true size, one must deduct from ½ to ¾ inches (1.27 to 1.9 cm.), in the vertical direction from the size shown by trans-illumination alone.

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Clinical Notes

THE TREATMENT OF ACUTE INFECTIONS OF THE MIDDLE EAR AND THE PREVENTION OF MASTOIDITIS *

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In March, 1924, at the suggestion of a prominent otologist, I. Friesner, I published a report of what I then believed, and have since found, to be an effective method for the treatment of patients with acute infections of the middle ear and for the prevention of mastoiditis.[1]

It is now seven years since I have begun to use this method, and I am able to report that in a series of 1,200 cases, the results were so gratifying that none can deny that it surpasses all other forms of treatment hitherto devised. Only nineteen patients of this series were operated on for involvement of the mastoid; six came to me after from four to six weeks of illness (the use of my method here was out of question), and they showed all the typical signs of mastoiditis; five of the remaining thirteen were cases in which there had been tenderness of the tip of the ear, and eight did not follow out the treatment.

Unfavorable comment has been advanced by some[2] who either have not used suction or have used a different form of suction from that which I have outlined. Their testimony cannot be considered. I still maintain that a patient with an acute infection of the middle ear (whether produced by staphylococcus, pneumococcus or streptococcus) who is given the benefit of this treatment early enough—before pus has reached the mastoid cells and the x-ray reveals any destruction of tissue—will more readily recover without involvement of the mastoid than under any other form of treatment. In patients in whom the mastoid is involved or in whom tenderness of the tip is shown, this method is not of any value as a preventive.

The method used is vacuum-suction applied by a special tube[3] devised for the purpose of relieving pus under pressure, thus insuring better drainage.

The principle of this method is based on the consideration given to the pathogenesis of mastoiditis and the anatomic peculiarities in the middle ear.

The anatomic configuration of the middle ear shows that the floor of the tympanum is 2 or 3 mm. lower than the lowest margin of the drum membrane, so that the longest incision cannot reach the most dependent portion of the tympanum. There is a similar dipping of the floor of the antrum below the aditus. It is obvious, therefore, that thorough drainage by means of incision alone is not possible, and that irrigation can wash out only some of the pus. Taking into consideration the fact that the progress of disease of the mastoid is favored by the presence of pus under pressure which causes a necrosis, one is confronted with the problem as to how to facilitate drainage from the dependent portion of the tympanum and reduce pressure from the vault.

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* Submitted for publication, May 9, 1928.

1. Schwartz, A. I.: M. J. & Rec. **119**:250, 1924.

2. Kopetzky, S.: Acute and Chronic Suppurative Otitis Media, Arch. Otolaryngol. **2**:379 (Oct.) 1925.

3. Schwartz's special ear vacuum-suction tube manufactured by C. M. Sorensen, Astoria, Long Island, N. Y.

In employing this vacuum-suction method, a long incision is made from the lowest portion of the drum to the superior wall of the canal. In withdrawing the knife, the incision is extended a fourth of an inch along the superior wall. The external canal is cleansed by Hays' ear suction tube. When there is marked tenderness of the mastoid, a short posterosuperior cut is made so that a Y-shaped incision with a V-shaped flap results. (This insures better drainage from the attic.) The end marked *A* (figure) is inserted in the ear, firmly enough to make the external canal of the ear air tight, the finger is placed at end *C*, while suction is produced by Yankauer's apparatus at point *B*.

I wish to emphasize strongly that vacuum should be used only when there is tenderness, and should not exceed two to three units of suction as measured by the gage of Yankauer's suction apparatus. As soon as enough vacuum is produced, the patient will wince, and the finger should be removed from *C* instantly. This operation is repeated several times until the external auditory canal, previously dried (by Hays' tube), shows pus, which obviously must have come from the tympanic cavity. Repeated examinations after removing the pus have never revealed any additional congestion which might have been caused by the negative pressure. The slight transitory hyperemia which may be produced is in all

Improvised vacuum suction tube devised by the author. The left hand holds vacuum suction tube attached to Yankauer suction apparatus; the right hand holds vacuum suction tube attached to the bulb syringe for home use.

probability beneficial (Bier's hyperemia methods). Further drainage can be obtained by changing the position of the patient's head. As long as fever and tenderness are the predominant symptoms, the patient should be kept in bed in a horizontal position and the head tilted so as to tip the floor of the tympanum and antrum allowing the pus to drain by gravity.

Irrigation by syringe is tabooed. Syphonage by means of the Lucas return flow ear glass tube attached to an ordinary fountain syringe is used not more than three times a day. (The bag should not be higher than from 6 to 8 inches above the level of the ear tube to avoid high pressure.) Following each cleansing and in the manner already described from 4 to 5 warm drops of Wright's solution[4] are instilled to produce osmosis. After the second or third week of treatment, and when all tenderness is gone, the patient is instructed to instill from 3 to 4 drops of Schwerd's solution[5] into the ear twice daily.

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4. Wright's solution: Sodium chloride, 0.30; sodium citrate and resorcin, of each, 1.20; distilled water, 30.

5. Schwerd's solution: Zinc sulphocarbolate (phenolsulphonate), 0.30; camphor water and alcohol, of each, 8.

For vacuum-suction treatment in the patient's home, a glass nozzle (figure) and an ordinary 3 ounce, soft rubber bulb syringe are used. Point *A* is inserted in the ear, and the tip of the syringe from which the air has been expressed is inserted into point *B*. The bulb expending causes a negative pressure of about two units (as can be measured by a gage). An icebag (Dr. Sprague's) should be applied constantly for from twenty-four to forty-eight hours or until tenderness disappears. At each office treatment, the upper air passages should be cleansed with Hays' suction tube and from 10 to 20 per cent solution of neosilvol applied.

In response to an article of recent date [3] in which suction has been condemned, I wish to say that the foregoing outlined method is not given to be used when the mastoid cells have been affected or in cases in which tenderness of the tip of the mastoid is present; it is urged only in early cases of infections of the middle ear as a preventive for mastoiditis. As I have already emphasized, I do not employ enough negative pressure to produce engorgement of the reduplicated folds in the mucosa of the attic so as to block the mastoid antrum from the middle ear and cause a stagnation of pus and enhance necrosis. I also wish to take exception to the statement that of all patients studied in whom suction had been employed, diminution in hearing greater than that which follows other means of treatment ensued. Every patient coming under my care has been tested for hearing at the cessation of treatment, and untoward effects have not been noticed. The otoscopic picture has never been so altered as to obscure judgment of the progress of the disease.

In conclusion, I urge all who are interested in this subject to give this method a trial; results will speak for themselves.

215 E. 12th Street, New York.

Progress in Otolaryngology

A Summary of the Bibliographic Material Available in the Field of Otolaryngology

ANATOMY AND PHYSIOLOGY OF THE EAR

REVIEW OF THE LITERATURE FROM OCTOBER, 1927, TO OCTOBER, 1928 *

PHILIP E. MELTZER, M.D.

BOSTON

The continued progress in the study of physiology of the labyrinth, while of great interest and importance, has not produced any more practical information than what has been presented in my previous summaries. The theories of hearing are still retained, while the old ones are refreshed to apply to the new facts of recent experimentation.

For information concerning the labyrinth, Bárány's tests are still employed, supplemented occasionally by modified methods, yet essentially Bárány tests. No really reliable and universally acknowledged method of testing the otolith apparatus has as yet been presented, though Tweedie, Quix, Versteegh and others have published tests which have some practical value.

Unfortunate indeed is the otologic world to have lost the services and inspiration of Professor Magnus of Utrecht. For many years the impulse given to the study of the labyrinth and vestibular tracts was chiefly due to his presentations dealing with the physiology of the otolith apparatus.

His associates who have so ably carried on this work with him are continuing his studies, and to them as well as to the others who have so generously contributed to the labyrinthine investigations, one must look hopefully for enlightment.

ANATOMY, HISTOLOGY AND COMPARATIVE ANATOMY

Hirsch,[1] using the silver impregnation dye method, studied the nerves of membrana tympani and external auditory canal. In the auditory canal he was able to demonstrate long capillary nerves, perivascular nerves and intra-epithelial nonmedullated nerve fibers, but no capsular apparatus. In the tympanic membrane he also found three nerve plexuses: (1) subepithelial, (2) submucous and (3) primary plexus. Here

* Submitted for publication, Dec. 26, 1928.

1. Hirsch, L.: Beitr. z. Anat. Physiol. Path. u. Therap. d. Ohres. **26**:129 (Dec.) 1927; abstr., Zentrabl. f. Hals. **12**:43, 1928.

he could also point out intra-epithelial nerve fibers, but no capsular apparatus. The blind end of the intra-epithelial fibers could not be demonstrated.

Luscher [2] described the topography and physiology of the cutaneous superficial blood vessels of the tympanic membrane in living man by means of the ear microscope.

The cutis strata of the tympanic membrane contains, closely below the epithelium, an extensive connected meshwork of capillaries and veins in three dimensions, which, in different arrangement and density, covers the tympanic membrane. At the margin it is directly connected with the corresponding superficial venous plexus of the external ear. The description of the details of the arrangement is not suitable for abstracting.

In spite of the different possibilities of outflow, there is a definite normal regulation of the discharge of the blood from the tympanic membrane. The middle third of the pars tensa yields its blood toward the umbo, and from there, along the handle of the malleus, over the cutis stripe to the upper wall of the auditory canal. The two outer thirds send their blood toward the periphery. The pars flaccida has its own irregular circulation. The afflux of the blood takes place in deeper strata, and is not visible normally. The nature and velocity of the blood stream, as a whole and in their details, show such considerable variations that one can hardly speak of a normal condition.

The superficial vascular plexus may, therefore, be divided into the following regions, anatomically as well as functionally:

1. The vascular plexus of the pars tensa
   (*a*) Central plexus
   (*b*) Peripheral plexus
2. The vascular net of the pars flaccida shrapnelli

The tympanic membrane is a suitable object for the determination of the capillary pressure. In the smallest capillaries this amounts to an average of 60 mm. of water, with extremes of 32 and 94 mm. of water. In somewhat wider vessels (about 40 microns), the average is 94 mm. of water with extremes of 56 and 136 mm. of water. The first values are the lowest that have been observed in man.

Normally, the majority of the vessels of the tympanic membrane are in a state of tonic contraction and closed to the blood stream, so that the stream channel, which in maximal dilation is broad, is normally limited to few vessels. In case of maximal dilation, the width of the stream channel may increase twenty-fold, and the volume-velocity, taken as a whole, may increase from one hundred-fold to two hundred-fold.

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2. Luscher, E.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:12, 1928.

Druss [3] concluded from histologic studies of the ligaments of the ear bones that:

1. The bones are united to each other by four layers of connective tissue (bone, calcified and hyalinized cartilage and an intermediate sheath).

2. The general view is that the bones do not form a joint of a high degree but a simple symphysis, which this author confirmed by his observations.

3. From thirty-seven temporal bones, only two pathologic changes have been found; once pus was found in the connective tissue and once hemorrhage in the capsule and in the cartilage. In the remaining cases, deviations from the normal may be considered as normal deviations, even such as ankylosis which may be considered as atavistic.

4. The joints between the ear ossicles are resistent to pathologic processes.

5. The fact that in deafness the joints between the ossicles may remain normal would lead one to conclude that they do not serve alone for acoustic function.

Meyer [4] gave a most interesting report of his investigations of the more delicate construction of the osseous tissue in the normal labyrinth capsule of man. According to most textbooks of histology, and according to the histologic literature, the two kinds of bone which occur in the body of the adult are called lamellar and reticular bone. The lamellated bone is predominant by far, while the reticular bone, which in the skeleton of the embryo and young child is still present to a large extent, plays only a subordinate rôle in the adult. In the labyrinth capsule a relatively large amount of the reticular bone remains preserved in the perichondral part during the entire life as residues from the embryonal period and first childhood.

In the enchondral capsule, according to existing conceptions, there are found as embryonal residues the cartilage-containing interglobular spaces, surrounded by what is always designated in the literature as a lamellated osseous tissue.

Theoretical reflections first awakened Meyer to the idea that this bone could not possibly be of lamellar construction as the Breccien arrangement was absent. To this was added the fact that staining of the bone fibrils showed that an interlacing of such fibrils and bundles of fibrils took place in characteristic manner, such as is impossible to occur in the lamellar system, in which, in the most ideal case, a lamella is a surface closed in itself. The examination of the enchondral labyrinth capsule in persons of all ages by means of fibrillar stains and polarized light, besides with the stains usually employed, revealed that, in fact, the osseous tissue of the enchondral labyrinth capsule is not lamellated, but is a peculiar bone-tissue, which, according to structure and genesis, should be called fine fibered, lamellae-free, marrow bone.

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3. Druss, J. G.: Monatschr. f. Ohrenh. **62**:257 (March) 1928.

4. Meyer, M.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:297, 1928.

The question now arises whether this lamellae-free, fine fibered osseous tissue could be considered a residue from the embryonal period, like so many other components of the labyrinth capsule, and if perhaps it does not also appear transitorily in the enchondral ossification of the other bones of the body which have a cartilaginous preformation, in order to disappear later or to be supplanted by lamellated bones.

Investigations made in this direction on bones of the extremities and vertebrae of fetuses and young children disclosed the correctness of this assumption, so that therefore the osseous tissue of the labyrinth capsule must be considered as a pronounced embryonal tissue, which preserved itself on this sole place in the body until the most advanced age.

The deposition of the bone substance occurs exactly in the same manner through the osteoblast chains as that of the lamellated bone. With hematoxylin-eosin stain, a difference can be determined with only relative difficulty. The staining of the fibrils and the polarized light are the first to show the difference in a distinct manner.

Why, in the embryonal period, and the first period of youth, the osteoblasts form this peculiar osseous tissue, and in later stages lamellated bones, cannot even be surmised.

Puntigam,[5] on the ground of macroscopic and microscopic investigations of the mallei of the cow, horse, dog and cat, described a cavity always present in the handle of the malleus, which, filled up in the microscopic picture, appears of a "chonchroid type" through its supporting tissues (cow and dog). In the cat, a typical cartilage is found; in the horse, a tissue, which calls to mind that hard cartilage "myxine" described by Schaffer.

Poljak[6] examined the nerve terminals in the macula and crista in rats of different ages by means of Golgi's method, and found, similarly to Lorente de Nó, that in the central parts of the crista and macula there exist fibers which embrace several cells with crypts, as well as regions in which the fibers form crypts only. He found in all of his sections, especially at the beginning of the crista, profusely ramified branchings of delicate axis cylinders which form a plexus. He regarded the foregoing morphologic and regional differences of the nerve terminals as types of a common, originally a uniformly diffusely distributed basic, type.

This differentiation is regarded as the expression of a special intensification, and perhaps also to a certain degree as a change of the functional tasks of certain localities of the naked sense surface.

Poljak[7] described in detail the innervation of the macula sacculi through two different nerve branches. This innervation has been previously studied by several authors.

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5. Puntigam, F.: Ztschr. f. Mikroskop.-Anat. Forsch. **12**:457, 1928; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **12**:477, 1928.

6. Poljak, S.: Ztschr. f. d. ges. Anat. **84**:131, 1927.

7. Poljak, S.: Ztschr. f. d. ges. Anat. **84**:145, 1927.

The one fasciculus which innervates the greatest part and the point of the dorsal lobe originates as a branch of the posterior vestibular branch of the most posterior part of Scarpa's ganglion. Some few fibers proceed from the anterior vestibular branch and run to the caudal end of the dorsal lobe. The most oral point of the macula sacculi is conjointly supplied by three macular fasciculi.

One may conclude therefrom that, as a whole, the macula sacculi must be regarded as an individual sense organ. It is possible that the oral end of the macula sacculi is embryologically as well as functionally a connective link between the macula sacculi and the macula utriculi.

The conditions are most distinctly differentiated in the cat. In regard to the so-called cochleovestibular fasciculus, in the cat there were two weak fasciculi in the spiral course of the cochlear nerve. According to the observations made on the rat, it may be a case of fibers emanating from vestibular nerve cells, which are only admixed with the cochlear nerve.

Portmann,[8] continuing his observations on the epithelial bands of the membraneous semicircular canal, stated that histologic examination of these canals shows that the epithelium presents zones of differentiation. Along the internal and external curvatures of the canal there are two narrow bands in which the epithelium is more dense than elsewhere. These bands present clearly defined relationships with the epithelium of the acoustic crests and with the vessels of the semicircular canals.

The internal epithelial band is accompanied by a large vessel which has the characteristics of a venous capillary. The external band is frequently in relation with a small vessel.

The cells of the bands are much smaller than in the rest of the epithelium, the nucleus is less regular in shape and is large. It often appears to be folded or incised.

These bands have been found constantly in many animals, not only in mammals but in fishes, frogs, toads and birds.

Although the bands do not present any of the characteristics of the neuro-epithelium of the acoustic crests, it is possible that they are in relation to nerves. The presence of relations of these bands with branches of the vestibular nerve would be of great interest in a study of the physiology of the semicircular canals. The author is making investigations along this line.

Funaoka and Toyota[9] studied the chemical nature and origin of the otoliths. According to chemical analysis, the otoliths of vertebrates consist mainly of calcium carbonate. Crystallographically, there are known two modifications of calcium carbonate, namely, argonit and colcit, which could be differentiated by means of roentgen rays. To which of these

8. Portmann, G.: Acta oto-laryng. **12**:211, 1928.

9. Funaoka, S., and Toyota, S.: Folia Anat. Japon. **6**:323, 1928.

two modifications the otoliths belong must be determined by roentgenologic examination. These authors, by such examinations, found that the otoliths and the otoconia were in small calcium sacs of argonit. The development of the otoliths is not clear. In the fishes, which as a rule have an unusually large statolite, they are not to be found in the cylindric cells of the sensory epithelium. It is assumed, then, that they apparently are expelled from the cells and form the basis for the development of the otoliths, since the calcium salts are deposited, layer by layer, around the endolymph. Funaoka and Toyota examined a series of prepared sections through the head of rana esculanta which were from 5 to 23 mm. in body length. In some of these which were of 6 mm. in length, they found in the labyrinthian vesicles a few lamellae which were colored blue by hematoxylin. They are in the form of somewhat longitudinal tablets with rounded edges and appear between the crossed prism as isotrophic and not in great number. Their number increases, but in none of those lamellae can an anisotrophic component be demonstrated. Funaoka is not in position at present to state definitely the origin of these isotrophic albuminous otoliths; nevertheless, he is of the opinion that they are probably detached portions of the epithelium of the macula and are expelled by them. From the foregoing observations, the otoliths appear to be formed from albuminous bodies which do not contain any calcium salts as yet. In these albuminous otoliths, the argonit crystallizes and later the calcium otoliths are formed.

Gray [10] gave a demonstration on the evolution of the round window and the aqueduct of the cochlea. In reptiles, with the exception of crocodiles, there is found a tube, which issues from the anterior margin of the cochlea into the recessus perilymphaticus. On the outer wall of this recess is the round window, and on the inner upper wall an opening, which leads into the arachnoidal space. This opening is developed ultimately in mammal at the perilymphatic aqueduct or the cochlear aqueduct. In birds, as in crocodiles, there is an opening between the scala tympani cochlea and the recesses perilymphaticus. In such primitive mammals as *Monotremata,* the perilymphaticus is a cavity with a narrow opening behind the scala tympani. The round window lies entirely on the wall of the recess and not on the cochlea wall. A long thin tube goes from the recess into the arachnoidal space. This tube corresponds to the opening of the recess perilymphaticus in reptiles (on the inner and upper wall). In kangaroos and *Marsupialia,* the perilymphaticus recess no longer exists as a separate cavity but is replaced by a strong vault on the floor of the scala tympani. The round window is in the wall of this vault and the cochlear aqueduct opens on the vertex itself. In higher mam-

10. Gray, A. E.: Acta oto-laryng. **12**:118, 1928; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **12**:190, 1928.

mals (carnivora, rodents, etc.) the vault is more level and the round window lies partly on the vault and partly on the wall of the scala tympani. The aqueduct opens at the protuberant part. In primates, particularly in human beings, the vault on the floor of the scala tympani is freely lost sight of, so that the round window lies entirely on the wall of the scala tympani. In them there is no longer observed in the soft parts a recessus perilymphaticus, but a furrow is supported in the bony structure, namely, in the vault of the promontory in the tympanic cavity and in the bony margin of the round window, that arises at a short distance from the membrana secundaria at the cavum tympani.

ANOMALIES OF DEVELOPMENT

Ruttin [11] cited the history of a family in which there appears a relationship between congenital fistula of the ear and auricular appendages. In one family, he found that the mother had a congenital fistula of the left ear at a typical place at the root of the helix; two children had a similar fistula at a typical place on the right side, and another child had a typical auricular appendage. This occurrence in members of the same family without other disturbances appears to point to the fact that both anomalies, at least in their most simple typical form, are to be regarded as developmental disturbances in the stage of the formation of the external ear from the auricular tuberosities.

Breuer [12] observed two congenital fistulas in the lobe which are considered rare. The histologic examination showed a canal lined with true epidermis. It was striking that the appendages of the skin, the sweat and sebaceous glands showed such a varying development.

The teratogenetic origin of this deformity falls into the time from the fourth to the fifth embryonal month. The formation of large congenital fistulas of the ear and around the ear, however, is connected with the development of the first and second branchial clefts and therefore evolves sooner. Fistulas at a greater distance from the ear are due to a deficient fusion of the processes of the upper and lower maxillae.

Krupsky [13] gave a survey of the literature and reported two cases of malformation of the ear. One case was that of a girl in whom the right pinna was rudimentary, the auditory canal greatly constricted and only 1.5 cm. deep. Hearing was preserved. The other case was that of a new-born girl with very rudimentary pinnae and absent auditory canals. During crying and while nursing, an air-containing tumor was formed over the mastoid process, evidently caused by the air escaping through an open fissura mastoideasquamosa under the skin, which is lifted.

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11. Ruttin, E.: Wien. med. Wchnschr. **77**:1019, 1927.
12. Breuer, Fritz: Deutsche Ztschr. f. Chir. **202**:278 (May) 1927.
13. Krupsky, A.: Ztschr. f. Laryng. Rhin. **16**:255, 1927-1928.

Jacques and Roig [14] described a child who had a malformed pavilion in its normal place and, in addition, a small nodule in the cheek of the same side containing cartilaginous tissue of the elastic type. Such cases are rare. In this case, it appeared that in its movement of ascension the pavilion had left a fragment which later developed. This was a rare case of dissociation of the embryonic pavilion rather than reduplication.

Kelemen [15] summarized the congenital abnormalities of the ear as:

1. Appendix praeauricularis duplex. Both protuberances have a cartilaginous nucleus, which in the case of one, loses itself in the deep tissues.

2. Appendix praeauricularis accompanied by "cat's ear" of slight degree with pronounced Darwin's tuberculum.

3. Wildermuth's ear: left, the anthelix projects beyond the plane which is theoretically determined by tragus and helix; right, "cat's ear" with severe mutilation; the entire upper half of the pinna is turned forward. The margin of the helix faces forward. Facial hemiatrophy is present on the right side.

4. Abnormal communication of scala media and posterior scala. The abnormal osseous canal is lined with dura the thickness of an ordinary probe, below the sulcus petrosus, at about the place where the occasionally persisting petrosquamous suture meets the pyramidal edge. It is possible that the canal forms a residue of the embryonal petrosquamous sinus with osseous covering toward the cranial cavity. A similar formation in this region has not been described. Its significance lies in the facility of the conduction of pathologic processes between the middle and posterial cranial fossa.

Eschweiler [16] described a case of congenital fissure of the tympanic membrane. Apparently this is a case of congenital anomaly not heretofore described.

PHYSIOLOGY OF COCHLEAR AND MIDDLE EAR

Bonain [17] remarked that there is reason to believe that a complex sound wave is dissociated like a wave of light. But the fact of the simultaneous perception of the principal elements of a complex sound indicates that this dissociation must be produced in the ear by refraction or diffraction. It is probable that it takes place by diffraction in the organ of Corti. This is a long tunnel formed of arches which follow

14. Jacques, P., and Roig, A.: Ann. d. mal. de l'oreille, du larynx **47**:545 (June) 1928.

15. Kelemen, G.: Zentralbl. f. Hals-, Nasen- u. Ohrenh. **12**:493 (July 25) 1928.

16. Eschweiler: Ztschr. f. Laryng., Rhin. **16**:105, 1927; abstr., Internat. Zentralbl. f. Ohrenh. **28**:344, 1928.

17. Bonain, A.: Ann. d. mal. de l'oreille, du larynx **47**:473 (May) 1928.

this spiral of the basilar membrane. Its situation in contact with the smooth zone of this membrane and the existence on its lateral walls of a network corresponding to two groups of auditory canals and surmounted by their resonaters is a strong presumption in favor of this dissociation or dispersion of the sound waves in the ear. It is hardly possible that these delicate arches do not play a rôle in audition. The tunnel which they form receives the sound waves which have passed through the tympanum, the various parts of the spiral and the smooth zone of the basilar membrane. These waves are diffracted and dissociated into their simple elements during passage through the lateral networks. Reflected under different angles, these simple sound waves reach different resonators and are impressed on different sensory cells.

Irueste y Roda [18] showed a parallel between the function of Corti's organ and of the retina. As the retina conveys the picture received for the whole brain, so also Corti's membrane conveys the hearing picture for the whole of the cerebrum. The granulated protoplasma of the ciliate cell is continually in Brown's movement. These movements constitute, as in mechanics, lines of force. These lines of force originate in each vibration, which effects the proper membrane, always in the same form, which corresponds to a fixed tone quality. These lines of force also constitute in a certain degree the "hearing picture." Corti's membrane is not perchance, as Helmholtz supposed, a resonator, which conveys the movements of the stimulated cell, for then an obliteration of the whole tone picture would arise, it is on the contrary an "apagador" that is an obliterator, which interrupts the conduction to a certain degree between the single tone pictures, separates the tone pictures from each other and it is thus made possible for each tone picture to be conveyed to the cerebrum separately.

The principle of maximal stimulation was presented by Gray [19] twenty years ago. In view of new experimental information and anatomic advances, he expressed the belief that this theory is strengthened, and restated it. He said, "We are only conscious of the stimulation of any one sensory receptor when the degree of its stimulation is greater than the adjacent sensory receptors, or inversely when a number of adjacent sensory receptors are stimulated we are only conscious of the stimulation of those particular sensory receptors which are at the points of maximal stimulation." (Example: on pressing with pointed instrument on the skin, one is conscious of only one point even though the surrounding area is being pressed on as is evidenced by the blanching around the point of pressure.)

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18. Irueste y Roda, J.: Med. Ibera **21**:580, 1927; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **12**:274, 1928.

19. Gray, A. A.: Acta. oto-laryng. **11**:30, 1927.

Gray maintains the theory that the basilar membrane acts as a resonator because he found, anatomically and physically, that the three factors, length, tension and mass, which govern the transmission of vibration of strings, are present in the case of the basilar membrane in exactly the relationships in which one would expect to find them, i.e., in basal whorl, large and fibrous in character, becoming less fibrous and smaller as the apex is passed.

He admitted that the fibers of the basilar membrane are so united that they do not vibrate singly in response to a vibration. Hence, if a given fiber were set in motion by a pure tone with which it was in complete sympathy, it would drag the adjacent fibers along with it. Furthermore, the adjacent fibers would themselves vibrate to a certain extent in response to the tone sounded, but they would not vibrate to the same extent as the fiber which would be in complete sympathy to that tone, therefore, in maximal stimulation and the only one heard.

Wittmaack [20] reported his observations on the functional significance of Corti's organ and the nonmedullated nerve terminals for the hearing act. He said that in studying the situation that exists in the presence of pathologic processes in the acoustic end-apparatus, three structures require attention, according to the anatomic composition of this organ: (1) the supporting apparatus, (2) the sensory cells, (3) the nonmedullated nerve fibers. With respect to the pathologico-anatomic processes in the end-organ of the eighth nerve, the author, in the course of years, has become convinced that a distinction must be made between two radically different pathologic processes; namely, hypertonic and hypotonic degeneration in Corti's organ. According to the stimuli which elicit the changes in Corti's organ exerting extremely hypotonic and hypertonic effects, two entirely distinct conditions will result, which likewise elicit and leave behind entirely different morphologic pictures in Corti's organ.

Hypotonic degeneration undoubtedly represents a relatively frequent disease and is a subject of considerable controversy. The essential feature in the anatomic changes in this form of degeneration consists of collapse, with flattening of Corti's membrane and organ and also progressive disappearance of cell differentiation of Corti's organ, leaving behind a uniformly shaped cellular eminence. Reissner's membrane becomes either transversely stretched out or may flatten out against Corti's organ. Both changes may be demonstrable in different convolutions of the same cochlea.

It is remarkable that clinical observations with subsequent anatomic investigations have shown that the changes described are not capable of inhibiting the act of hearing, but that, on the contrary, a remarkably

20. Wittmaack: Acta oto-laryng. **12**:1, 1928.

good, although by no means absolutely normal, hearing capacity may still be present in spite of the onset of these changes. His explanation is that the condition is a simple retrogressive process without cellular disintegration, which leads to an advancing undifferentiation of the individual cell types. In consequence, the contact between nerve and cell, which is maintained by the nonmedullated nerve fibers, evidently persists also in this retrogressive process and the hearing function is maintained. Wittmaack does not deny the possibility of error in technic in the preparation of these tissues, but the repetition of the results and the extreme care exerted would seem to be in his favor.

The conditions are altogether different in hypertonic degeneration, which undoubtedly represents a much rarer disease than hypotonic degeneration. The anatomic changes here entering into consideration are met with especially often in cases of deafmutism. The essential feature in this form of degeneration consists in the extreme detachment of Corti's membrane from Corti's organ, or actually in its complete liberation from its base in a somewhat higher degree of this form of degeneration. The membrane then lies in the form of a rolled-up ball covered with flattened epithelium, somewhere in the vicinity of Corti's organ or on the basilar membrane. Corti's organ appears either entirely lost or transformed into a noncharacteristic epithelial eminence, although it is sometimes remarkably well preserved with persistent columnar cells and tunnel space. Sometimes the different degrees in intensity of this change are found in the individual convolutions of the same cochlea. Reissner's membrane is bulged out or strongly plicated. Hypertonic degeneration is characterized from the start by well marked disintegration, in the first place of the sensory cells themselves, and thereby, of course, also of the nonmedullated nerve fibers in contact with these cells.

The supporting apparatus of Corti's organ can hardly be credited with a decisive functional importance for the auditory act. "Undifferentiation" of the supporting apparatus including its sensory cells, with preserved contact between cell and nerve through persistence of the nonmedullated nerve fibers, does not arrest the hearing act. Disintegration of the sensory cells and of the nonmedullated nerve fibers in contact with these cells leads to deafness also under preservation of the supporting apparatus and relatively well preserved nerve fibers and ganglion cells.

Kerekes,[21] on the strength of numerous experiments based on the relationship between endolabyrinthine pressure and function of hearing, arrived at the following conclusions:

1. A decrease of an increased blood pressure may favorably influence the symptom of acoustic hypo-esthesia.

21. Kerekes: Ztschr. f. Hals-, Nasen- u. Ohrenh. **18**:458, 1928.

2. An increase of the endocranial pressure is accompanied by a decrease of hearing by bone conduction.

3. The transformation of the acuity of hearing goes hand in hand with the decrease of endocranial pressure.

4. The three foregoing results of the investigation constitute experimental proof for the fact that normal hearing demands an optional degree of the endolabyrinthine pressure.

Mendoza [22] named as three duties of the tympanic cavity: (*a*) protection of the inner ear against loud noises, (*b*) accommodation, (*c*) sound transfusion.

In the protection of the inner ear against loud noises, the two middle ear muscles in close relation with the eustachian tube play the leading rôle. In atresia of the tube, the tympanum, by reason of contraction and reduction of movement of the membrana tympani, the protection mechanism of the inner ear, is disturbed. There exists a hypersensitiveness for loud tones and deafness for weak sound impressions. The second duty of the middle ear is accommodation. Normally, following movements of the muscles, there results a pull of the membrana tympani inward, the tympanic cavity is made smaller, the intralabyrinthine pressure is increased and the hearing grows more acute. The mechanism cannot change because the ligamentous apparatus allows only certain movements of the auditory ossicles. In further support of his theory, the author stated that the upper part of the tympanum is adapted to low tones, the lower part to high tones. Therefore, a perforation in the upper section of membrana tympani disturbs hearing for lower tones and one in the lower section, for high tones. The relations between the middle ear and the hearing cease to exist when the membrana tympani is cicatrized, or when its movement is strong. Persons without tympanic cavities do not have complete hearing because they cannot accommodate. When facial paralysis occurs, and with it paralysis of the stapedius muscle, the membrana tympani moves toward the labyrinth so that some disturbance of hearing results, which is caused by the increased intralabyrinthine pressure. In considering the third duty of sound transfusion, the author only reviewed the well known theories.

Pohlman [23] stated that it is not yet clear whether the lesion present in the cochlea when exposed to prolonged acoustic insult is due to excessive stimulation dependent on pitch and intensity and therefore a criterion of a specific area of reception, or whether the cochlear degeneration is due to fatigue of the intrinsic muscle and clatter of the ossicles. In the second case, the lesion would be dependent on the pitch. Practically all experimental animals except small rodents show evidence of cochlear degeneration when thus exposed. Pohlman expressed the belief

22. Mendoza, R.: Ann. de la Soc. Mexicana de oft. y oto-rino-laryngol. **6**:143, 1927; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **11**:759, 1928.

23. Pohlman, A. G.: Proc. Soc. Exper. Biol. & Med. **24**:896, 1927.

that the mouse escapes these lesions because in the small rodents the stapes is traversed by the large artery which must certainly act as an efficient and a tireless damping mechanism.

PHYSIOLOGY OF THE LABYRINTH

Vestibular.—Undric,[24] in a study begun in Utrecht in Magnus' laboratory and completed in Leningrad, stated that the nystagmus is a complicated phenomenon in which at least six muscles take part. To analyze this movement the author has used the technic of Lorente de Nó. From the numerous nystagmograms (500) of the single eye muscles obtained in this manner, the author came to the following conclusions:

1. In rotation in a horizontal plane, a reciprocal innervation takes place. In nystagmus, toward the left, the musculus rectus externus dexter and the musculus rectus externus sinister are contracted equilaterally and the musculus rectus externus dexter and the musculus rectus internus sinister innervated. In nystagmus to the right, the opposite is true.

2. In horizontal nystagmus a single muscle suffices—internus or externus. Each muscle thus evokes the swift as well as the slow components of nystagmus.

3. The threshhold of excitability of the vestibular apparatus forms the angle of acceleration of 3 degrees in a second.

4. Tonicity of muscle in rotation depends on the centrifugal force and can therefore be ruled in connection with the otolith apparatus.

5. In rotation in the frontal plane, the musculus rectus superior and inferior are contracted, in rotation in the sagittal plane, the musculus obliquus superior and inferior (reciprocal innervation).

6. In rotation in the frontal and sagittal planes, nystagmus is shorter than nystagmus in the horizontal plane.

7. Contraction of the muscle in calorization is also subordinated to the rule of reciprocal innervation.

8. After a median bisection of the floor of the fourth ventricle, it is not possible to cause a nystagmus, neither by rotation nor by calorization: the paramedian section of the fourth ventricle, on the contrary, calls forth a spontaneous nystagmus which is arrested by calorization of the ear.

9. The last experiments show the functional significance of the contralateral fiber of the vestibular nerves (which in the region of the vestibular nucleus connect with each other and with the oculomotor centers of the other side), they are necessary for the presence of nystagmus.

Lorente de Nó [25] reported that by means of registration of the labyrinth reflexes after lesion in the nerve centers and histologic analysis of the operated brains, the following conditions have been demonstrated: The vestibular reflexes may appear in the muscles innervated by the trochlearis and oculomotor nerve, also when the posterior longitudinal

24. Undric, V.: Rusak, oto-laryng. **21**:5, 1928; abstr., Zent. f. Hals. **12**:535, 1928.

25. Lorente de Nó, R.: Acta oto-laryng. **12**:243, 1928.

bundle has been bilaterally divided between the vestibularis and oculomotor nuclei. The reticular substance in the pons and midbrain takes an important part in the elicitation of the three reflexes, also the slow phase of the nystagmus. Through lesions in the reticular substance, the rapid phase of the nystagmus can be inhibited, under preservation of the slow phase. The current classification into centers for the individual reflexes is not correct; the entire column of reticular substance cells, which is connected with the vestibularis, participates in the elicitation of all ocular reflexes.

From a series of experiments, Undritz [26] came to the following conclusions:

1. The minimum perceptibility of the vestibular apparatus of a rabbit, measured by the rotation reaction, lies in the great ordinance of an angular deviation of three per second.

2. In rapid rotation the tonic contraction of the eye muscles is increased, the nystagmus becomes less and more frequent.

3. The muscle tonus, which exists during rotation and after the fading away of the nystagmus, must be explained by the action of the centrifugical force and is closely connected with the otolith apparatus.

4. Irregular rotation has a slight influence on the postnystagmus, so far as the number of rotations and the general duration remains unchanged, that is the mean velocity of rotation remains the same.

5. Optical influences have a subordinate rôle in the vestibular nystagmus of the rabbit.

6. Even in complete darkness a typical nystagmus and postnystagmus may be demonstrated only after a few rotations.

7. When revolving in the frontal plane, contractions and relaxations take place, mainly in the superior and inferior muscles, whereas rotation in the sagittal plane the oblique muscles undergo contractions and relaxations.

8. The nystagmus and postnystagmus is of shorter duration after rotating in the foregoing planes than in the horizontal plane.

9. After a sagittal section of the fourth ventricle, a typical nystagmus may be produced either by calorization or by rotation.

10. A paramedial section of the fourth ventricle produces a spontaneous nystagmus. In these cases, one may frequently observe the slow phase by experimental irritation.

11. The last experiments prove the functional importance of the contralateral vestibular fibers—they are important for the production of typical nystagmus in peripheral vestibular irritation.

Démétriades and Spiegel [27] carried out experiments on guinea-pigs which showed that when there was nystagmus to the sound side caused by the removal of one labyrinth, and this had reached the stage of com-

26. Undritz, W.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **16**:444-460 (Feb.) 1928.

27. Démétriades, D., and Spiegel, E. A.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **19**:250, 1927.

pensation, the destruction by cauterization of the cortex of the ipsolateral cerebellar hemisphere (without involvement of the cerebeller nuclei or bulbar terminations of the vestibular nerve) changes the nystagmus to one directed toward the side of the eliminated labyrinth.

Grahe [28] said there is no uniform opinion as to the significance of the cerebellum in the production of nystagmus. He performed vestibular functional tests on a man in whom the right cerebellar hemisphere was absent; he also agreed with the observations of various other writers that the removal of the cerebellum results in a diminution of excitability of nystagmus as compared with the normal. In this case, rotatory and spontaneous nystagmus was more on rotating to the right than to the left. There was definite past pointing with the left arm; the right arm exhibited severe ataxia. The reactions to the caloric test were as follows: the left ear was syringed with cold water. After one minute there was nystagmus to right and past pointing with the left hand toward the right. The right ear was syringed; after fifteen seconds there was nystagmus to left lasting three minutes and past pointing error toward the right, especially with the right hand. These were such regular observations that it is apparent that the cerebellum is not of a necessity in the production of nystagmus although it does influence it.

From another case the author concluded that the mechanical and caloric irritations had influenced the substance of the cerebellum by direct irritation. These results are in agreement with numerous experiments on animals in which through a light irritation of small cortical areas of the cerebellum, there resulted definite eye movements.

It is also known in some human cases that nystagmus is absent even in extensive abscesses of the cerebellum. Since, on the other hand, numerous authors have observed that the removal of cerebellar abscesses results in disappearing of the nystagmus, so others assume that the nystagmus appearing in cerebellar abscesses and directed toward the diseased side results from the effect of the pressure on the oblongata.

If these views would apply only to a small number of cases one would not assume on the basis of the observations that the resulting nystagmus might be evoked directly from the cerebellum.

Lorente de Nó [29] summarized the results of his many experiments as follows: It appears certain that the development of the rapid phase of the nystagmus, as Bárány asserted in 1907, is dependent on the intactness of the reticular substance in the pons, and it appears necessary that the neurons from which the rapid phase of the nystagmus is evoked are connected with the vestibularis nuclei.

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28. Grahe, K.: Ztschr. f. Laryng., Rhin. **17**:99, 1928.

29. Lorente de Nó, R.: Monatschr. f. Ohrenh. **61**:1066, 1152 and 1300 (Dec.) 1927.

It appears, as yet, impossible to determine the nature of this connection, and the internal mechanism of the evocation of the nystagmus. It appears to be a fact, demonstrated by the experiments, that the necessary stimulations emanate from the peripheral labyrinth, in order (in the absence of other, for instance, optical stimulations) to determine both slow and rapid phase. One naturally must not think that each of the two phases of the nystagmus is dependent on another terminal place in the labyrinth, but solely on the fact that a single stimulus, for instance, in the crista of a semicircular canal, evokes a diphasic reflex, for example, as the skin irritation evokes the scratch reflex. This perhaps was the opinion of Breuer. The labyrinth irritation may have a different modality according to the rotation, and this modality of the labyrinth excitation determines the amplitude, and therefore, in unchanged velocity of the slow phase, also frequency of the nystagmus.

Ohm [30] illustrated, by means of kymographic curves, nystagmus produced under various conditions. He stated that revolving in a dark room produces a retarded revolving nystagmus of a small amplitude and frequency and a powerful postnystagmus of a long duration.

The amplitude of the nystagmus produced in the presence of light is considerably greater than that of darkness.

He also examined six miners with nystagmus. He stated that the reaction of the vestibular apparatus when the rotation takes place in the vertical axis is variable in miners with nystagmus. If the caused nystagmus is influenced by the horizontal canals, he assumed that the nerve endings in the vestibule are of greater significance for the mechanism of miners nystagmus than the ampules.

Balabonina [31] presented a later proof of Ohm's conjecture that latent strabismus is a predisposing factor in the appearance of nystagmus. Balabonina examined 1,000 normal human beings, between the ages of 16 and 60 years, who have never worked in a mine, for the existence of latent strabismus and in relation to this concurrence with nystagmus in extreme direction of vision. It was discovered that, in accord with the statements of another author, heterophoria, and mostly exophoria, is to be found in 79.5 per cent of all cases in normal human beings. Also, a temporary nystagmus was noted in 34.6 per cent and a constant nystagmus in 11.9 per cent of all cases.

Quix [32] based his study on the fundamental idea that the canals are always oriented in three planes perpendicular to each other. A geometric analysis of vestibular nystagmus shows that there are twenty-six forms. He said a knowledge of these forms is important in both physiology

30. Ohm, J.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **19**:467 (Feb.) 1928.

31. Balabonina, L.: Russk. oftalmol. zurual. **7**:60, 1928; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **12**:424, 1928.

32. Quix, F. H.: Arch. internat. de laryng. **7**:117 (Jan.) 1928.

and otology. It makes it possible to define immediately the site and nature of the irritation which has caused the nystagmus and explains why a pathologic nystagmus of labyrinthine origin shows only a few forms, while nystagmus of central origin may show any of the forms.

Camis [33] performed experiments on cats and rabbits to see if destruction of the labyrinth would produce any modification of the antagonistic innervation of the muscles.

These experiments are given in detail and permit the conclusion that destruction of a labyrinth exerts a remarkable influence on the mechanism of the antagonistic function of the skeletal muscles.

The influence of the labyrinth extends to the muscles on the same side of the body since no effort is produced on the muscles of the opposite side. The experiments described in this paper confirm and amplify the result of the author's previous experiments relative to the action of the labyrinth on the antagonistic innervation of other mechanisms (vasomotor and iridomotor). They also confirm the author's theory that the tonus, whether labyrinthic or cerebellar, must be considered as being the result of the two normal components of the reciprocal innervation of the muscles.

Pietrantoni [34] stated that from experiments performed on the antagonistic muscle groups in the larynx of the dog, the influence of the labyrinth is absent as contrasted with the other antagonistic groups. In his opinion, the less a muscle group has to do with static function of the body, the less impulse does it receive from the labyrinth. Thus the antagonistic innervation of the laryngeal muscles is not regulated through impulse of vestibular origin and is not changed by destruction of the labyrinth.

Wittmaack [35] understands by tonus not the absolute pressure which dominates throughout the cuticular structure but the equally distributed pressure which results from the antagonistic effect of the intracupular and endolabyrinthine pressures. The author also expressed the belief that from these researches it may be concluded that the organism strives to maintain this equal distribution of pressure so that the increase of the endocupular pressure would not conform to such an increase of endolabyrinthine pressure and vice versa. These changes in tonus of the sensory endings produce, according to the best of galvanic irritability, no essential changes in the irritability of the sensory endings. Similarly, they do not lead to any clinical symptoms besides occasional changes in

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33. Camis: Arch. ital. de biol. **78**:178 (Jan. 30) 1928.

34. Pietrantoni, L.: Valsalva **4**:249, 1928; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **12**:534, 1928.

35. Wittmaack, K.: Arch. f. Ohen-, Nasen. u. Kehlkopfh. **117**:241 (April) 1928.

the muscular tonus of the musculature of the body which still requires a more thorough test. The appearance of apparent clinical decompensation symptoms cannot be ascribed to the changes in tonus but must be brought in close association with further accompanying symptoms. In animals treated with atrophine, one has to deal apparently with the direct effect on the peripheral nerve endings; the effect of pilocarpine, on the other hand, have to do with the symptoms that directly concern the labyrinth which are expressed in extreme increase of tonus of the cupula (separation of continuity with momentary depression of intracupular pressure). The author previously considered that these symptoms are to be explained in injury of the peripheral nerve in consequence of pressure paralysis.

Frenzel [36] described a case in which there was a dorsal nystagmus due to slow rotating of the head, the labyrinth was in a state of nonirritability. The only explanation would be that the irritability of the deep muscle sense produced the nystagmus and this signifies a neck reflex. On the basis of the published literature and his own observations, he said that the neck reflex in man extends to the eyes which appear only under special conditions and act in the sense of a compensatory eye movement. He is unable to state the nerve mechanism of this reflex.

Otolith Organ.—This contribution by Lorente de Nó [37] is a continuation of the author's article published in the *Scandinavian Archives of Physiology,* in 1926, on the explanation of the enormously complicated nuclei and tracts of the vestibular nerve. His observations can be summarized as follows: The labyrinthine function is restricted: (*a*) To give the head and the eyes during rest a firm position in space (compensatory eye and head movements). During rest, the labyrinth certainly induces no reflex phenomenon in the extremities, and when a reaction results, it cannot be the so-called tonic peripheral reflex, for these reflexes would tend to flex the animal's paws, that is, to render standing impossible. (*b*) To perceive the accelerations of the head to which it is subjected. In response to these accelerations, reactions result which can be divided without much difficulty into: (1) reflexes to progressive movements; (2) reflexes to rotary movements or sensations, respectively, in the human subject. The labyrinth probably gives rise to no other reflexes; the author said "probably," because unilateral extirpation of the labyrinth is followed by a decreased tonus of the homolateral extremities which has not yet been elucidated.

The otolith membranes in the author's opinion functionate as follows: the otolith membranes are formed of a viscid fluid in which cal-

36. Frenzel, H.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **21**:177, 1928.
37. Lorente de Nó, R.: Acta oto-laryng. **11**:362, 1927.

cium calculi are embedded; they are extensively attached to the margins of the maculae at the undifferentiated epithelium, so that the margins of the otolith membranes are unchanged. For this reason, the old Breuer theory of the gliding of the otoliths in a definite direction is absolutely untenable; a displacement of the otolith membranes as a whole cannot take place in any direction. Between the otolith membrane and the macular epithelium there exists a dense fluid through which pass the hairs of the hair cells in order to come in contact with the otolith membranes. As a closed space filled with fluid is being dealt with, changes in volume must be left entirely out of consideration. Bending of the hairs of the hair-cells can be produced only in deformities of the otolith membrane. The surface forces in connection with the inertia forces (weight of the otoliths and the intermediate substance) determine a state of equilibrium for every position of the head. When the position of the head is changed or when the head is given an acceleration of some kind, the inertia forces are different; the shape of the otolith membranes will change proportionately, and in consequence, the state of flexion of the hairs of the hair-cells will be modified. The result is a new otolith stimulation.

Werner [38] made a study of the function of the otoliths of fish and the facts found support a theory that is much like that published by Wittmaack on the cuticular structures. The otolith acts by producing a difference of pressure, as a result of its weight, between the fluid of the labyrinth and the cupula (otolith membrane). When the head lies on the right side of the saccule, the otolith brings about two things; it tends to pull the median wall of the saccule, to which is attached, downward and thereby produces hyperpressure in the right saccule. Probably no real movement generally takes place because, of course, the endolymph is not compressible and the utriculosaccular canal, when it is present, makes rapid compensation difficult. On the other hand, the otolith necessarily produces a negative pressure in the space between it and the sensory epithelium. But here compensation is possible, as the subcupular spaces immediately above the sensory epithelium have a connection with the anterior part of the macula or the free part of the cupula. There the hypopressure of the cupula and the hyperpressure of the endolymph come into immediate contact. The otolith of the opposite side, of course, works in just the opposite direction. The fibrous cords which connect the two saccules probably serve to bring about a harmonious cooperation of the two sides.

This theory results from a study of the morphologic facts and corresponds to these facts better than the old gross mechanical theory. No

38. Werner, C. F.: Arch. f. Ohren-, Nasen- u. Kehlkopfh. **117**:69 (Nov) 1927.

decided opinion can be expressed as yet in regard to the macula utriculi for its structure and particularly its function is essentially different.

Zimmerman [39] stated that the absence and transformations of the otolith plate in centrifugated experimentation animals do not always evoke an absence of the tonic labyrinth reflexes. The compensatory ocular deviation, which disappears after the centrifugating, may restore itself also if the otolith membrane is torn away.

The tonic nystagmus which appears as an expression of an otolith irritation in a certain posture of the head, is not supportable by experimental observations on animals.

Groebbels,[40] studying the posture and motor reflexes of birds, performed many interesting experiments. At first, one side of the labyrinth in pigeons was entirely or in part removed, and after degeneration had set in, the corresponding operation was subsequently performed on the other side.

In the case of simultaneous bilateral intervention, the oscillation of the head commences with a movement toward the side on which operation was last performed. In the case of corresponding intervention carried out at different times, however, the oscillation of the head begins with a movement toward the side on which operation was first performed.

The results in many of Groebbel's experiments would seem to demonstrate that after removal of the ampullae the maculae must retain their full functional capacity, and, furthermore, that cristae as well as maculae participate in the torsion of the neck.

The characterization of the labyrinth posture reflexes on the neck as otolith reflexes must therefore be in error.

Chiloff,[41] studying the effect of irritation of otoliths on reflexes of semicircular canals, concluded that: 1. The changing of the position of the head in space is the specific excitant of the otolith apparatus. 2. Diagnosis of the so-called isolated conditions of the otolith organ is not definitely nor clearly marked. 3. The semicircular canals and the vesicle of the vestibule simultaneously contribute to caloric compression and postrotary nystagmus.

Sixty normal persons were tested in the Bárány chair with the eyes closed and the head forward, so that the frontal canal was in the plane of rotation. Patients were turned ten times in twenty seconds and the duration and character of the nystagmus noted. After an interval, patients were turned again in the same direction, but at the termination

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39. Zimmerman, G.: Zentralbl. f. Hals-, Nasen- u. Ohrenh. **11**:710 (Feb. 25) 1928.

40. Groebbels, F.: Arch. f. d. ges. Physiol. **218**:408, 1927.

41. Chiloff, C. Z.: Rev. de laryng. **48**:691 (Nov.) 1927; ibid **48**:721 (Dec.) 1927; abstr., Arch. Otolaryng. **7**:185 (Feb.) 1928.

of the turning the head was raised to vertical position. In 95 per cent of cases nystagmus was shortened by the change in the position of the head. As some authorities contend that the shortening of the nystagmus was due more to the neck reflex than to the otolith organ, the author placed cats in plaster casts and repeated the experiments, with the same results.

In order to destroy the function of the otolith membrane, cats were placed in a centrifuge and turned at the rate of from 1,000 to 2,000 revolutions a minute. The experiment was repeated after three days. It was found that changing the position of the head did not have any influence on the nystagmus. The labyrinths of the cats were sectioned, and the specimens showed the otolith membrane detached.

In order to measure the amount of past pointing and deviation in falling, or what the author called body nystagmus, he devised a system of scales. Patients were submitted to turning with the head in a forward position. The falling and the past pointing were feeble in 94 per cent and medium in 6 per cent. On raising the head, however, to the vertical after turning in the lowered positions, he found that the reactions were feeble in 32 per cent, medium in 34 per cent and strong in 34 per cent.

Caloric Physiology.—Traina [42] said that, according to Bárány's hypothesis, stimulation of the acoustic crests during the caloric test is brought about by movements of the endolymph produced by a difference in temperature between two distant points in the endolymphatic circulation. The author criticized some of the physiologic tests that have been made of it, saying that in making the tests the experimenters have created unphysiologic conditions. He works it out by purely physical methods, determining the velocity that may be assumed by the endolymph in the semicircular canals during the caloric test and the angular acceleration, determined by the rotating chair, that is equivalent to the effect of the difference in temperature between two different points in the canal during the caloric test. The details of the experiment and the mathematical calculations by which the velocity of the endolymph and the angular acceleration are determined are given. The author concluded that other factors, such as thermal stimulation and vasomotor disturbances, bring about the vestibular reaction during the caloric test, movement of the endolymph possibly being involved to a slight extent.

Hartmann [43] described the technic of his experimental investigations of caloric nystagmus in the isolated eye muscles of the rabbit and gave curves showing the details of the results. If conclusions in regard to a functional relation are to be drawn from the curves it seems probable that the caloric nystagmus of the external and internal recti is dependent

42. Traina, S.: Valsalva **3**:454, 1927.
43. Hartmann, Ernst: Acta oto-laryng. **11**:556, 1927.

chiefly on the horizontal semicircular canal. It also seems probable that the obliques at the points where their curves coincide with the curve of the horizontal canal for the same side are essentially influenced by stimulation of the horizontal canal, though the conditions here are probably much more complicated. The curves of the semicircular canal show two places (where the canal is vertical) that are broader than the other parts of the curve, which is probably due to the fact that here the point in the canal that is stimulated calorically is in a labile position with regard to the direction of the current for a greater number of degrees than at other places.

Uffenorde,[44] in continuing his former experiments of attempting to evoke caloric nystagmus by applying cotton pledgets which were saturated with ether to the horizontal semicircular canal of persons and apes who have undergone radical operations, found that, in applying two small pledgets in front and behind the crest of the semicircular canal at the same time, no nystagmus sets in, while if the application is not exactly simultaneous it does take place.

In accord with Bárány's theory, the nystagmus is dependent on the position of the head.

RÔLE OF THE SYMPATHETIC SYSTEM IN OTOLOGY

The study of vascular spasms in otology is too recent for any definite conclusions to be formulated. However, the literature is beginning to accumulate and the future holds promise for enlightment for many symptoms referable to the ear, the causes of which are at present not determinable.

Démétriades,[45] in the study of the mutual relationship between the labyrinth and the vegetative nervous system, stated that the great distribution of the vestibular nerve in the medulla oblongata and its numerous collaterals by means of which this nerve is connected to nuclei of other nerves, offers the possibility of an abundant reflex action (somatic as nystagmus, as well as vegetative—vomiting, turning pale, etc.).

The vasomotor disturbances of the human auditory apparatus involves the cochlear as well as the vestibular apparatus. On the one hand, stimulating phenomena are being dealt with, and on the other hand, abolition or decrease of function due to disease or extirpation, for example, subjective noises, auditory disturbances, vertigo, disturbances of equilibrium, spontaneous nystagmus, past pointing error. All the foregoing symptoms are not always present; but even in cases in which the ear is apparently normal and in which there are symptoms of

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44. Uffenorde: Verhandl. d. Südwestdtsch. Hals. u. Ohrenarzte, 1928, pp. 35-36.

45. Démétriades, T. D.: Wien. klin. Wchnschr. **40**:1471, 1514 and 1544 (Dec.) 1927.

vertigo, tinnitus and vomiting, one may always find a slight vasomotor injury to the labyrinth.

The author mentioned Politzer's "angineurotic acustic paralysis" which Kobrak named "angineurotic octavus crises." It would appear from the author's observations that most frequently these vasomotoric disturbances of the ears are partial symptoms of a general vasoneurosis, as subjective auditory symptoms (parathesia, tinnitus and vertigo), spontaneous nystagmus and the fatigue phenomena are frequently found in neurotic persons. In general, pathologico-anatomic disturbances do not occur in this functional disease.

It appears that due to vegetative disturbances, the portal to the nerve elements are interrupted, and as a result of the established vasomotoric disturbances a point of minor or least resistance is formed. Various processes in the sexual life (puberty, climacterium, menstruation, pregnancy, etc.) exert a certain influence on the inner ear, probably due to the intervention of the vegetative nervous system.

At any rate, the vasomotoric disturbances are always demonstrated clinically as early symptoms. It is probable that the spastic process preponderates in the inner ear during irritation phenomena and later form a state of paralysis. The latter may also be found in early intoxications caused by phenobarbital, salicylates, quinine, arsenic, etc. According to experiments of the author with the tonus of the labyrinthal vessels, the labyrinth exerts an inhibiting impulse, on the one hand, on the vasoconstrictor centers of the vessels of the head, and on the other hand, on the vasoconstrictors which control the total blood pressure. There exists, therefore, a cetrain antagonism between the labyrinth and the sympathetic action on the blood vessels. Whether the observed slow pulse in labyrinthitis is a pure action of the labyrinth has not been determined. The general fall in blood pressure following labyrinthine irritability is also followed by an anemia of the brain, which leads to sensation of dizziness and which is sustained in stimulation of the vagus. These reflex actions of the labyrinth are active even after extirpation of the vagus and the midbrain. After extirpation of the labyrinth, the vasoconstrictor factors take the upper hand.

Portmann,[46] who has done considerable work in the study of the rôle of the sympathetic in relation to the ear and who has contributed largely to the present literature on this subject, stated that the normal circulation of the ear is under the direct dependence of the periarterial and cervical sympathetic nerves on one hand, and on the other hand, it follows the laws of the regulation of the general circulation.

Action on the cervical or pericarotid sympathetic nerves results in the appearance of vasomotor phenomena in different parts of the ear.

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46. Portmann, G.: Rev. d'oto-neuro-opht. **6**:255 (April) 1928.

There is vasodilation and ischemia if there is a stimulation. The vasodilation with hyperemia if the sympathetic nerve is sectioned.

The auricular response is not elective according to the sympathetic nerve on which operation has been performed. The vasomotor phenomena are produced in the entire auditory apparatus whether the operation is performed on the cervical sympathetic or on the pericarotid sympathetic nerve. This seems to furnish proof of the interdependence of the two sympathetic systems in the ear.

Although the vasomotor reactions occur in all parts of the ear, in either case, they are more marked in the internal ear when the pericarotid sympathetic nerve is operated on and more marked in the external ear when the cervical sympathetic is concerned.

While no peripheral vasomotor modifications were found, the experiments showed that the vagosympathetic drugs had a direct action on the vestibular apparatus, and there is reason to believe that this action is produced by means of circulatory disorders.

Terracol [47] stated that the sympathetic seems to play an important part in the internal ear. Experimental studies of the production of the nystagmic reflex are conclusive in animals; they have seen verified in man either by action on the superior cervical ganglion or by action on the periarterial sympathetic of the internal carotid. In addition to the hydraulic phenomena caused by physical laws, there are vasomotor phenomena.

Baldenweck, in discussion, objected that perhaps a nystagmus brought about by sympathectomy is a nystagmus of cervical origin. In addition to nystagmus of labyrinthine origin, it is generally admitted that there is also a nystagmus caused by stimulation of deep cervical sensation.

Perekalin [48] described the results of his studies on the influence of labyrinth stimulation on blood pressure. He thought that rotary excitation causes first diminution, then rise of blood pressure over the original value. There is temporary conformity with the duration of nystagmus, but no parallel between the strength of the nystagmus and the blood pressure reaction. Strength of the blood pressure reaction in different experimental animals is different. Injection of epinephrine delays the appearance of the reaction. Separation of the halsvagus and the sympatheticus has no influence on the reaction. Injection of 10 per cent solution of cocaine through the round window suppresses the appearance of the reaction. Mechanical stimulation of semicircular canal causes lowering of the blood pressure.

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47. Terracol: Arch. internat. de laryngol. **7**:117 (Jan.) 1928.

48. Perekalin, V.: Abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **11**:710, 1928. Ber. d. 5. allrussischen Kongress der Oto-laryngologers in Moskau, April, 1927, pp. 26-30.

Torrini [49] gave protocols of his experiments on rabbits which show that the cervical sympathetic does not materially affect the nystagmic reaction to caloric stimulation of the vestibular labyrinth and still less the reaction to rotatory and galvanic stimulation. This was shown by the fact that in experiments in which the cervical sympathetic was resected there was no appreciable change in the reaction, and still further confirmed by an experiment in which he stimulated the stump of the excised nerve with the faradic current without any change in the reaction. Though vasomotor phenomena are caused in the internal ear after lesion of the cervical sympathetic, as the author has found in previous experiments and is shown by clinical experience, these vasomotor phenomena do not affect the reaction to caloric stimulation of the vestibular labyrinth to any appreciable degree.

Portmann and Despons [50] performed experiments on dogs with epinephrine, extract of ergot nitritis, phyostegmine salicylate, pilocarpine, atropine and belladonna preparation.

The authors found that the drugs used produced the general specific actions which have always been attributed to them. However, they were not able to find any manifest and constant peripheral vasomotor phenomena. There were no disorders of the mucous surfaces indicating a vasoconstrictive or vasodilative action. On the other hand, the pupil did not undergo any characteristic vascular modifications.

They found constant disorders of excitability of the vestibular apparatus. Drugs having a direct action on the sympathetic seemed to produce a constant vestibular reaction: stimulants of the sympathetic caused hyperexcitability and inhibitors of the sympathetic caused hypoexcitability.

Portmann and Maisonobe [51] reported on some clinical observations. The first case of the authors was that of a man who had violent vertigo following a surgical operation in the deep region of the neck. This vertigo gradually decreased without any treatment. The patient never had tinnitus. All examinations showed vestibular hypo-excitability.

This case is interesting in many respects. It concerns disorders of the vestibular apparatus which could be attributed to a transitory paralysis of the sympathetic. The symptoms observed could be explained by a vasodilation of the labyrinth similar to that obtained by cocainization of the superior cervical ganglion or by section of the sympathetic in the neck or by pericarotid sympathectomy. There were no signs of congestion of the external auditory canal or the tympanum. It was probable that a lesion of the sympathetic fibers passing to the vertebral artery was produced during the operation. There was an

49. Torrini, U. L.: Arch. ital. di otol. **38**:731 (Dec.) 1927.
50. Portmann, G., and Despons, J.: Rev. de laryng. **49**:1 (Jan. 15) 1928.
51. Portmann, G., and Maisonobe: Rev. de laryng. **49**:291 (May 15) 1928.

associated mydriasis of the left eye. Hence there was a dissociated sympathetic syndrome consisting of stimulation of the eye and paralysis of the vasomotors of the internal ear.

The second case gave the authors an opportunity to observe the effect of carotid sympathectomy on the right side and ligation of the left carotid on vascularization of the internal ear. This patient had requested the operation to be relieved from vertigo. Before the operation, the patient presented a syndrome of vascular hypertonicity of the labyrinth characterized clinically by vertigo and tinnitus.

The pericarotid sympathectomy on the right side seemed to have had a bilateral action shown by a decrease of the vestibular excitability in all points comparable to the results obtained by other authors in pericarotid sympathectomy. Sympathectomy resulted in a modification of the arterial circulation of the labyrinth. The circulation became more active and was manifested by the disappearance of the vertigo and objectively by a decrease in the vestibular excitability appreciable by caloric tests.

The ligature of the left common carotid did not appear to have any effect on the vestibular reactions. In fact, the postoperative results were identical on both sides and this indicates that it was the sympathectomy alone which decreased the excitability.

Nishimura,[52] by excitation of an acoustic nerve of a rabbit by a special electrode, caused the dilation of the pupil on both sides. This depends in part on reflex excitation of the sympathetic system and in part on antagonism of tone in the motor oculi. The effect is less on the side stimulated. Pain is without influence on the results.

Terracol [53] said the sympathetic is involved in a whole series of manifestations in the auditory apparatus.

Oto-erythrosis is particularly interesting when it is unilateral and seems to be in relation with a paralysis of the cervical sympathetic system. It is often isolated but is sometimes associated with pupillary and brachial manifestations. The ear is warm subjectively, and objectively, it is red and hot without any change in volume. The attack is precipitated by mental work. Pruritus of the external ear is often associated with oto-erythrosis.

Portmann,[54] in a paper read at the Congress of French Oto-neuro-ophthalmologic Societies, presented the view that excitation of the cervical sympathetic nerves and ganglions about the carotid artery causes vasoconstriction and ischemia, and that their section creates congestion

52. Nishimura, H.: Compt. rend. Soc. de biol. **97**:158, 1927; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **11**:704, 1928; abstr., Physiol. Abstr. **12**:516, 1927.

53. Terracol, J.: Médecine **9**:298 (Jan.) 1928.

54. Portmann, G.: Congress of French Oto-Neuro ophthalmol. Soc., 1928; abstr., J. A. M. A. **91**:813 (Sept. 15) 1928.

of the external ear, the tympanum and the labyrinth, sometimes with a marked improvement in hearing.

Portmann also studied the effects on local thermic action, and associated them with vasodilatation. The medicants that act on the sympathetic nerves when employed in these cases are of inconstant action, with the exception of epinephrine. From these experimental and clinical facts, Portmann has developed a "syndrome of labyrinthine angiospasm," that is, a buzzing sound in the ears, dizziness, deafness, vestibular hyperexcitability and hypertonia of the sympathetic nerves, in apposition to which there is a "syndrome of hyptonia." The two syndromes may alternate in the same patient, such alteration being a sign of neurovegetative dystonia.

CLINICAL LABYRINTHINE OBSERVATIONS

Cevolotto [55] found that the diathermic test is a real improvement over the ordinary test by irrigation. It can be used in any case and is independent of lesions of the external and middle ear. It also gives quantitative data in regard to the condition of the labyrinth. An intense current in the deviation test causes variations within certain limits even in the normal ear. The theory of the movement of the endolymph proposed by Bárány is the most plausible explanation of the facts, but it alone does not suffice to explain them all. The concussion of the tympanic membrane certainly facilitates the appearance of the reaction.

Musseij,[56] in his experimental study of the diathermic induction of nystagmus, expressed the same opinion as that of Cevolotto, but according to him, the great fluctuation in the duration of the latent period and the duration of the nystagmus, which is longer than in the usual caloric tests, makes the diathermic methods of producing nystagmus unsuited for practical application.

Kompanejetz [57] found that in disease of the labyrinth when the usual methods of examination fail, testing by counter-rolling is effective. He has often made the correct clinical diagnosis in this way and he thinks that the use of this test will contribute to a further development of the clinical picture of disease of the otoliths. He described the case of a patient, aged 36, with acute disease of the labyrinths following an external furuncle of the ear. The position in which this patient felt the least dizziness and the results of the counter-rolling test in this and another case make it seem plausible that the maximum stimulation of the otoliths does not take place on pressure but when they are suspended, that is, it argues in favor of the theory of Magnus and Kleyn and against

55. Cevolotto, G.: Minerva med. **7**:1011 (Sept.) 1927.

56. Musseij, I.: Abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **11**:711, 1928.

57. Kompanejetz, S.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **19**:231 (Oct. 28) 1927.

that of Quix. An examination of the tonus of the upper extremities to determine whether there is disease of the otoliths is the least reliable of all the methods. There is not always one position of dizziness in otolith disease. On the contrary, there may be only one position in which the dizziness is least marked, probably as a result of minimum stimulation of the vestibular saccules. Disease of the otoliths is manifested not only by a disturbance of the counter-rolling of the eyes toward the normal side on inclination of the head toward the diseased side, but also by a disturbance of symmetry in the movements of both eyes, that is, a disturbance of associated eye movements.

Veits [58] described the technic of examination with weak caloric irritation. In order to obtain exact comparative values, the following arrangement is recommended: The head of the patient is inclined about 20 to 30 degrees, under the guidance of the eye, 10 cc. of water between 20 to 27 degrees is then injected with a glass syringe and blunt cannula within seven seconds against the posterior upper wall of the auditory canal, next to the attachment of the tympanic membrane.

If thereafter, in exceptional cases, nystagmus to the opposite side manifests itself, then the head is still more inclined until the nystagmus disappears. In case of nystagmus to the same side (very rare) the head is elevated slightly. Exactly one minute after the beginning of the irrigation, the head is bent backward 90 degrees, within two seconds. After this, the latency period up to the beginning of the nystagmus is determined by means of a stop-watch, and the nystagmus movements are counted during sight straight forward with Bartels spectacles. A slight rotation sensation is thereby perceived. Vertigo is normally completely absent. This test has the purpose of performing the irrigation in the indifferent position, in order to achieve the full cold effect already at the beginning of the nystagmus test. This effect manifests itself in about one minute. The maximum posture is the most suitable for this test. The number of nystagmus movements is more important for the evaluation than the duration. The finer differences in the nature of the nystagmus may be observed with great exactitude after short practice. With exact observation of this method one obtains exact results in the comparison of both labyrinths and for the comparison with the average. As a matter of principle, a double irrigation is performed prior to the unilateral test of every semicircular canal apparatus, first, in order to determine through the double-irrigation-nystagmus a unilateral hypoexcitability or hyperexcitability, and also in order to achieve Kobrak's sensitization prior to the test of the separate labyrinths.

Chilov [59] reported his method of the functional test of the otoliths. Experimental investigations on dogs disclosed that the nystagmus does not

58. Veits, C.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **19**:542, 1928.

59. Chilov, K.: Zentralbl. f. Hals-, Nasen- u. Ohrenh. **11**:710 (Feb. 25) 1928.

genetically represent a specific function of the otolith apparatus, so that the so-called otolith nystagmus is no reliable symptom for a lesion of the otolith apparatus.

Pure otolith reflexes are unknown in man, but an approximate decision regarding the excitability of the otolith apparatus may be gained on the strength of the following tests of the double reactions: The first test (control experiments) is done by rotating the individual on the rotating chair with the head inclined downward (ten turns in twenty seconds). Nystagmus, the fall-reaction, the index reaction and the strength of the vegetative reflexes are determined without changing the posture of the head. The reflexes observed here depend on the currents of endolymphs in the frontal canals.

The second test is done fifteen minutes later. Rotation is performed exactly as in the first test with the head in the same posture, and with the same strength. After stopping the revolutions, the head is elevated to the vertical posture, the same reactions are observed. Now, besides the movements of the endolymphs, an irritation of the otoliths apparatus has taken place.

It was thus revealed that this irritation of the otolith apparatus has an influence on the reflexes of the semicircular canals. In the second test, namely, the nystagmus is materially shortened but, on the other hand, the fall-reaction, index reaction and the vegetative reflexes are distinctly increased.

The otolith apparatus may, therefore, be regarded as a transformer of the labyrinth energy, which is chiefly conducted by way of the vestibulo-spinal-reticular tract, and to a lesser degree by way of the longitudinal vestibular tract.

The persons who are examined may, on the strength of this double test, be divided into three groups: intolerant, tolerant and medium.

Guttich [60] remarked that by the Pilvert's test which he demonstrated in 1924, in bending the head toward the right the center of gravity of the body is also displaced to the right. However, the turning of the head is, as a rule, accompanied by automatic displacement of the shoulder girdle and the trunk, therefore, the center of gravity is to the opposite direction. In other Pilvert experiments it may be demonstrated that the direction of the past pointing error depends less on the position of the head in space but more on the displacement of the center of gravity of the body.

The past pointing after irritation of the ear labyrinth is not a pure vestibular reaction, but it is influenced by the tonus of the musculature of the neck. As a result of this there is displacement of the position of the head and this again adds its effects to the vestibular irritation

60. Guttich: Ztschr. f. Hals-, Nasen- u. Ohrenh. **21**:198, 1928.

which results in the point reaction. The vestibular irritation influences the entire muscular system, for with more severe irritation there may be produced past pointing by the tension of the cervical vertebrae. The very movable head makes an especially favorable point of attack for the action of the muscles.

The author stated that since the discovery of the physiology of the vestibular apparatus a spontaneous past pointing is considered as a symptom of a disease of the cerebellum. Bárány assumed the presence of a center of direction in the cerebellum from which tonic influences emanated on the extremities. This spontaneous past pointing of the diseased brain is influenced to a higher degree by the extension of the cervical vertebrae than by the artificial vestibular irritation. As long as the cervical vertebrae are stretched the patient points properly; as soon as the head becomes free, the past pointing automatically appears. These symptoms were to be observed appearing spontaneously in all tumors of the brain which were examined. Goldstein and Riese have shown that spontaneous disturbances effect the entire muscular system and that they are more prominent in one or another position. It is therefore the spontaneous past pointing of the diseased brain which affects the entire body, or at least half of it is due to a change of tonus. The spontaneous past pointing is, therefore, of great importance in the displacement of the center of gravity of the body.

Lipschutz [61] described in detail his research with Bárány's graphic method of the different reactions before and after rotation or caloric stimulation in many persons with normal vestibular apparatus. It is interesting that the author has found the so-called inverse or inverted postrotary reaction, that is, past pointing to the opposite side after rotation, first observed by Malan, later by Benjamins and Roorda, as frequently if not more so than these well known authors. But the author has been able to observe an inverse deviation reaction in only one of his patients, who also presented inverted past pointing. The author means that in this inverse pointing reaction, there is probably a question of a correction or an overcorrection, either conscious or unconscious, in the act of the pointing movement and that this correction factor does not appear in simply stretching the arm outward (deviation reaction). Only six persons showed complete normal postrotary reaction, seven a total inversion of the past pointing, and twelve partly normal, partly inverse reactions in a different combination. After caloric stimulation, the author has observed an inverse pointing reaction only once in a patient who also presented inverse past pointing after rotation.

Fischer [62] said that the degree of variation of the postrotary nystagmus following clinical rotation (ten turns in twenty seconds) is exceed-

61. Lipschutz, E.: Acta oto-laryng. **11**:424, 1927; abstr., Zentralbl. f. d. ges. neurol. **47**:757, 1928.

62. Fischer, M. H.: Zentralbl. f. Hals-, Nasen- u. Ohrenh. **12**:202, 1928.

ingly great. An attempt is made to show that this cannot be traced to individual differences alone but that the method of the test should be rejected as unsuitable and presented his minimal rotation test.

Charousek, in a discussion of Fischer's demonstration of the minimal rotation irritation, said that it proved clinically of no value for the same reason that Fischer objected to the usual test. He said that it is of importance to eliminate every excitation at the beginning of the irritation. The measure (duration and velocity) of the constant rotation is then more of secondary importance.

Abstracts from Current Literature

Ear

Remnants After Destruction of the Labyrinth. M. Weusthoff, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:210 (Sept. 5) 1928.

The author reports a case with histologic specimens, of a spontaneously healed, destroyed labyrinth, in a patient who succumbed to an abscess of the brain and meningitis. Wittmaack names this final stage, "phthisis of the labyrinth," because newly formed connective and osseous tissues take the place of the destroyed soft parts of the labyrinth and of the osseous labyrinthian capsule. In the patient whom the author describes, the destroyed osseous and membranous labyrinth was replaced by compact bone with the exception of the vestibulum which was filled with connective tissue. Zange reported sixty-seven cases of necrotizing inflammation of the inner ear among 228 cases of inflammation of the middle ear in which histologic examinations had been made. Among them, twenty-nine cases exhibited secondary necrosis with abscesses in the inner meatus.

The result of the formation of an abscess in the inner meatus is a discontinuation of the current of blood to the membranous labyrinth following pressure on the vessels in the internal meatus. The membranous labyrinth is provided for exclusively by the arteria auditiva interna; its branches are terminal arteries. The constriction of this blood supply causes at least the degeneration of the membranous labyrinth, according to Friedrich, Nager, Lange and Hegener. Siebenmann has shown that the whole osseous capsule of the labyrinth, with the exception of the innermost layer, the compacta interna, is not provided for by the arteria auditiva interna but, to a large extent, from the vessels of the meninges. The author observed a more extensive ossification of the connective tissue in the region of the semicircular canals and the cochlea than in the vestibulum, just as Preuss and Steurer noted previously. Preuss, Zange and Goerke stated as the reason that parts of the labyrinth react differently to the inflammatory irritation resulting from the formation of new connective or osseous tissue. The area of the ramus vestibularis showed a profuse formation of new fibers. Lange regarded this phenomenon as the expression of an excessive regeneration growth, and his view is generally accepted.

Artificial Labyrinthitis in the Guinea-Pig. W. Undritz, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:288 (Nov. 10) 1928.

Chloroform, instilled in the guinea-pig (Brown-Séquard), causes a labyrinthitis even if the drum membrane is intact.

1. The serofibrinous labyrinthitis of the guinea-pig brought about by chloroform has an extraordinary pathologic appearance, because the substance causing inflammation shows its effect in the distance.

2. The window dialysis experiments made by Wittmaack and his pupils have proved that the labyrinth reacts to irritating substances either by hypersecretory symptoms (hydrops) or by inflammatory processes (toxic inflammation), the variation in reaction depending on the nature of the irritating substance. Chloroform produces mainly inflammatory processes. Both reactions can be found in the same inner ear.

3. Labyrinthitis in the guinea-pig is an example of a pure induced form, because the toxic substance shows its effect on the inner ear at the time when a middle ear is not affected essentially.

4. The membrane of the round window represents the pathway. The most severe changes were found in its neighborhood. A direct effect through the osseous labyrinth could not be denied, because symptoms of inflammation were seen in the cochlea and ampullae of the horizontal and frontal semicircular canals.

5. In the guinea-pig, the cochlea protrudes into the bulla, so that chloroform diffuses to the inner ear before the mucous membrane of the middle ear can react. Besides, an idiosyncrasy toward chloroform may exist in the guinea-pig.

6. A suppuration of the middle ear need not always favor a propagation to the labyrinth. In the rabbit and the rat, it seemed to neutralize the effect of the toxic substances. The irritating substance acted by quick penetration before the middle ear could react.

7. The functional elimination of the labyrinth of the guinea-pig takes place at a time when inflammatory changes cannot yet be seen histologically.

8. Serous labyrinthitis shows a decided tendency to heal and to be confined, so that a partial restitution of the function occurs frequently. The semicircular canals are especially resistant.

Pharmacologic experiments permit the conclusion that the labyrinth can be incapacitated in the guinea-pig by halogen methane combinations. They act on the inner ear electively. Chloral hydrate in a solution of ether, instilled in the meatus of the guinea-pig, causes narcosis. Eckel wrote about the same subject but more from the anatomic standpoint; he found, after three and six hours, degenerative changes in Corti's organ. The author states that the animals had to be examined while hanging, or lying on the side, or calorically, because in the guinea-pig, even after unilateral extirpation of the labyrinth, many symptoms are compensated. According to Magnus, after a few days, the animals lose the turning motion of the head, the nystagmus and the difference of tonus of the extremities caused by the removal of one labyrinth.

AMBERG, Detroit.

Nose

RETROBULBAR OPTIC NEURITIS. SCHEERER, Arch. f. Augenh. **99**:322 (July) 1928.

This paper is devoted essentially to the subject of retrobulbar neuritis. The author states that, in the past seven years, he has seen 200 cases of retrobulbar neuritis, of which at least 55 per cent were caused by multiple sclerosis. From 4 to 10 per cent were definitely due to disease of the nasal sinus, and from 15 to 20 per cent were suspected of originating from disease of the nasal sinus. The rest resulted from general causes. In considering retrobulbar optic neuritis, he states that in numerous cases the disease of the optic nerve is the first sign of multiple sclerosis. In regard to those cases that are due to disease of the nasal sinus, he states that the interpretation of the clinical picture in cases presenting symptoms of sinus disease is frequently more difficult in the cases in which multiple sclerosis is obviously present. The rhinologists are not unanimous in regard to the significance of these changes. Scheerer raises the question, which others also have raised, whether disease of the nasal sinus does not prepare the ground for the development of multiple sclerosis, and he states that actually there has been a series of cases in which, in spite of successful operations on the nose, multiple sclerosis later developed. Of twenty-seven cases observed in 1927, six showed disease of the nasal sinus. The author briefly reports these six cases, the majority of them being typical cases of retrobulbar optic neuritis originating from disease of the nasal sinus. He reports also, briefly, a case with undoubted symptoms of multiple sclerosis, with a clouding of the nasal sinuses shown on roentgen examination, and another case that showed the typical evidences of retrobulbar neuritis of nasal origin, in which the operative outcome apparently was successful, but in which the patient died later, obviously of multiple sclerosis.

He mentions a third cause for the symptoms of retrobulbar neuritis, namely, such general causes as circulatory disturbances, etc. He speaks about the so-called reflex neurosis, or vascular spasms, and advises that in all cases of retrobulbar neuritis one should wait as long as possible before operating, and should always think of the possibility of multiple sclerosis.

CONCERNING THE SO-CALLED BLOOD CYSTS OF THE ORBIT. GOLOWIN, Klin. Monatsbl. f. Augenh. **81**:1 (July) 1928.

Golowin states that the former classification of blood cysts of the orbit was comparatively simple, the cysts being divided into so-called hematoceles and hematocysts. In the newer literature, they have been called extravasation cysts. He feels that the classification should be changed, and offers a new classification, consisting of three groups, the first of which he classifies as encapsulated hemorrhages, although these are not really cysts. The second group consists of cysts already present that show a hemorrhage, either spontaneous or as a result of trauma, and the third consists of cysts of tumors of the orbit which are formed by blood elements, such as the angiomas and all tumors undergoing hemorrhagic changes.

He presents three cases illustrative of the three different types, and describes his method of surgical procedure on these cysts. Apparently there are two operative procedures; one he calls the orbitotomia simplex and the other the orbitotomia ossea, which is a modified Krönlein operation, and which, according to Golowin, presents five distinct advantages over the Krönlein operation. He states that the differential diagnosis between the blood and other cysts is difficult, and that even more difficult is the recognition of the different types of the blood cysts. The rapidity of the appearance of the symptoms and the pigmentation of the lid indicate an acute development of the blood cyst in normal orbital tissue, which is the first type. Changes in volume (the extent of the exophthalmos speaks for a relapsing hemorrhage) are possible either in a cavity already present or in a tumor. The rapid development of an exophthalmos, which is especially typical of malignant neoplasms, can come from bleeding into the tumor.

At operative opening of the cysts, the blood seems to be in an unchanged condition in the first and the third types. In the second type, on account of the contents of the cyst already present, color changes are often encountered. After the operation, a correct diagnosis of the cyst is possible by means of a study of the capsule and the contents.

The only therapy for blood cysts is an operative one: in the case of the orbital cyst, the cyst with the capsule should be extirpated; in the case of the subperiosteal cyst, the capsule should be carefully removed after a wide opening of the orbit.

The prognosis of blood cysts depends on the type of cyst encountered.

VAIL, Cincinnati.

Miscellaneous

RETROBULBAR NEURITIS. H. HERZOG, Arch. f. Augenh. **99**:292 (July) 1928.

Herzog divides his clinical material of seventy-five cases of retrobulbar neuritis into two groups. The first group consisted of twenty-eight cases, in twelve of which the condition was due probably to hysteria, alcohol, arteriosclerosis and multiple sclerosis. Only four of the remaining sixteen cases in this group showed disease of the nasal sinus. The patients in the first group were those who came to the hospital on account of their eyes.

The forty-seven patients in the second group did not complain definitely about the eyes, but entered the hospital because of nasal sinusitis. Careful examination of the eye disclosed some evidences of retrobulbar neuritis, particularly an enlargement of the blind spot. Those in the second group were the only cases of retrobulbar neuritis found by the author in 500 cases of suppuration of the nasal sinus from 1919 to the beginning of 1927. In 435 of the 500 cases of suppuration of the nasal sinus, the condition was chronic, and in sixty-five it was acute. Symptoms of retrobulbar neuritis were found in thirty-three cases of chronic suppurative sinusitis, and in fourteen cases of acute sinusitis. The ophthalmologic observations varied from extensive scotoma with appreciable enlargement of the blind spot, to a slight enlargement of the blind spot with normal visual acuity.

In thirty-four of the forty-seven patients in the second group, the changes were so slight as to be disregarded. There were, then, thirteen cases which presented

definite characteristics of retrobulbar neuritis. In other words, 2.6 per cent of the patients with nasal sinusitis showed signs of retrobulbar optic neuritis; six of these occurred in cases of chronic inflammation, and seven in cases of acute inflammation, of the sinuses. There were 435 cases of chronic, and sixty-five cases of acute, nasal sinusitis, which clearly showed the preponderance of disease of the optic nerve in the acute processes. Changes of the optic nerve were from seven to eight times more frequent in cases of acute nasal sinusitis than in cases of chronic nasal sinusitis.

In discussing his statistics, the author states that retrobulbar optic neuritis is a comparatively rare complication of infection of the nasal sinus. He compares his figures with those of Markbreiter, Wallis and van der Hoeve which, he feels, must be questioned, for if the high percentage which they report existed, retrobulbar optic neuritis would be a daily occurrence in the clinics.

The author discusses the importance of realizing that the gross pathologic changes in acute sinusitis may consist of some edematous swelling of the mucosa, with the presence of little, if any, pus. He raises the question, "What kind of an inflammatory process can spread to the optic nerve, with few visible changes in the superficial region of the mucosa?" He proceeds to derive an answer from data obtained from the study of microscopic sections of the nasal sinuses in cases of acute and chronic infection. He states, however, that he has been unable to verify his observations in a true case of retrobulbar neuritis of nasal origin, on account of the scarcity of material obtained at autopsy.

Herzog states that below the mucosa and submucosa of the nasal sinuses there is a spongy space of larger or smaller cavities, the marrow spaces, filled with a loose connective tissue and communicating with the mucous membrane of the nasal sinuses. The bone in general is of moderate thickness in the optic canal, because of its relation to sphenoid and ethmoid cells, although occasionally it may be thinner with larger or smaller dehiscence. If dehiscences are present, the submucosa and the dura lie against each other. Here and there in the section a blood vessel may place the mucosa and dura in direct connection.

In addition to these well known facts, there is, according to Herzog, an important one, previously disregarded, namely, the richness of the marrow spaces. In some specimens, serial section will disclose that the marrow spaces on the one hand pass directly into the submucosa, and on the other hand open freely into the dura. In the other cases, which are, however, in the minority, the compact bony wall of the sinuses is changed by the large marrow spaces into a structure resembling spongy bone. These cases show the unbroken submucosa passing into the marrow spaces. Processes originating in the dura are mingled with the submucosal processes in the network of the marrow spaces. Occasionally the dural processes traverse the marrow spaces and reach the submucosa.

The blood vessels make an even closer connection between dura and mucosa through the marrow spaces.

Histologic study has shown the intimate relation between the optic nerve and the nasal sinus through the discovery of the direct connection between the superficial part of the nasal mucosa and the dural sheath of the optic nerve. Although the opening into the marrow spaces from the side of the nasal sinus is always appreciable, the approach from the dural side to the marrow spaces is open only exceptionally.

According to the author, infection in the nasal sinuses passes readily into the marrow spaces and finds a favorable location. The greater the spongy formation of the bone and the larger the marrow spaces the more favorable conditions are for a rapid extension to these spaces from the submucosa. This produces the clinical symptoms of acute rhinitis.

Herzog mentions the scarcity of suitable material for the microscopic study of the acute nasal infections. He reports a case of acute frontal sinusitis with the usual clinical symptoms, and gives the observations on histologic studies as follows: "There is a well preserved epithelium which is damaged only in spots, perhaps from friction and abrasion due to packing. The mucosa and submucosa are

infiltrated with small cells, and there are the typical signs of acute inflammation in the marrow spaces. Every capillary is surrounded by serous infiltration; the marrow spaces are thin and the delicate network is distended. The individual blood vessels are plainly seen, and in the immediate region of the vessels, the connective tissue cells are much swollen, while in the periphery the cells are pressed against the bone so that circular, definitely encapsulated and demarcated vascular regions result, which on first sight make an unusual impression."

The study of this case and others, led Herzog to conclude that the inflammation of the superficial layers of the submucosa of the sinus is sufficient to produce edema in the depths of the marrow spaces. This edema can be present to a considerable extent without any definite changes in the mucosa. He states that the inflammation can pass to the marrow spaces without any changes being microscopically visible in the superficial layer of the mucosa, and, furthermore, that the slight changes in the superficial layer can disappear in a short time, whereas the infection goes on unchanged in the marrow spaces.

If the nasal sinuses in this state of the disease are opened, the operator finds at times a reddish jelly-like granulation tissue mass, obviously the marrow spaces, which are markedly edematous, and extremely rich in blood. The surgeon is disappointed in not finding any free pus, and the operative report reads something as follows: "Nothing but granulation tissue and swollen mucosa," or, "At operation, no definite changes."

Herzog stated that his practice of making a careful microscopic study of material from every operation should be followed if knowledge of the changes in acute sinusitis is to increase. The conclusions made heretofore which have been based on macroscopic observations alone are to be rejected. They have brought into discredit the whole question of the retrobulbar optic neuritis of nasal origin.

According to the author, the force of the inflammation depends on the virulence of the organism, and the degree of spongiosity of the bone. A wide plate of bone with numerous large marrow spaces will offer a weak defense against the infection, whereas a thin compact wall will offer a strong one. The dura, further, is a strong bulwark against inflammatory attacks. If its resistance is overcome, the leptomeninges and the optic nerve succumb to the inflammatory changes.

If this is true, a retrobulbar optic neuritis can be expected in the early stages of virulent infections of the nasal sinus of rapid onset and progress, whereas in the chronic nasal sinusitis, any noticeable effects on the optic nerve will come only from acute flare-ups. This becomes obvious when one considers that the delicate network of the marrow spaces is increased and strengthened with cellular elements scattered through as a result of the many inflammatory attacks. This leads to narrowing of the marrow spaces by thickening of the connective tissue and the formation of new bone. Microscopic section in regions in which the new bone formation seems to predominate shows the charges clearly. Therefore, according to the author, the pathologic changes in cases of acute nasal sinusitis consist of edema and vascular changes in the marrow spaces. In the chronic forms of nasal sinusitis, however, the microscopic picture shows, besides the edema and infiltration and engorgement of the vessels, the formation of new bone by osteoblasts, with a marked narrowing of the marrow spaces which are filled with cellular elements. The author illustrates these changes with thirteen drawings of microscopic sections.

Herzog states that although the marrow spaces are especially significant as a route for the spread of infection, this is by no means the only way in which the optic nerve can be injured. The other possible routes are dehiscences in the bony walls or vascular connections between sinus mucosa and dura.

Herzog does not believe these possible routes as common as heretofore considered. In rare cases a thrombosis, an embolism or a compression of the vessels supplying the nerve can produce the clinical picture.

Herzog quotes a case reported by de Kleijn and Gerlach in which autopsy disclosed chronic suppuration of the sphenoid sinus with a spread of the infection into the marrow spaces of the dividing wall between the optic nerve and the

sphenoid. There was circumscribed infiltration of the sheath of the optic nerve on a spot opposite the sphenoid sinus. This infection had passed along a small vein to a point near the dividing wall. The optic nerve showed interstitial optic neuritis with vacuolization.

In discussing the importance of the marrow spaces as the route for infection from the sinus mucosa to the optic nerve, Herzog points out that this case shows at least that it is possible for sinus inflammation to reach the intracanalicular portion of the optic nerve by the route through the marrow spaces. He states that his conception of the cause of retrobulbar optic neuritis of nasal origin is a circumscribed serous meningitis which spreads to the optic nerve from the diseased sinuses by means of the marrow spaces.

If a chronic nasal suppuration exists, treatment consists in the removal of the disease of the sinus. Herzog seeks the procedure for those cases which do not show definite disease of the nasal sinus, but which do not exclude a nasal focus. He can imagine the objections of the rhinologist to surgical intervention in sound tissue. Must the rhinologist submit to the dictate of the ophthalmologist and intervene surgically when the ophthalmologist has exhausted every other means of combating the condition, and when the last hope lies in nasal therapy? Another way than surgical intervention to obtain beneficial results is by what Herzog terms Daueranämie or prolonged anemia. This extensive anemia is produced by means of pledgets of epinephrine inserted into the middle meatus after infraction of the middle turbinate. The pledgets are inserted along the posterior angle of the middle meatus to the sphenoid ethmoidal recess, and into the ostium of the sphenoid when this is seen. These pledgets are allowed to remain for two hours and are removed by the patient himself. This is done twice daily, morning and afternoon. Frequently the result of this method of treatment is astonishing. It has often cleared up the symptoms, although in some cases relapses have followed, which required surgical intervention. He reports one patient who showed prompt clearing up of symptoms, following the prolonged anemia, but who had a relapse which led later to surgical treatment. He recommends the use of Daueranämie in all cases as it is a clear point in the differentiation between the retrobulbar optic neuritis of nasal origin and that due to multiple sclerosis. In addition, he advises a complete examination of the cerebral spinal fluid, as the differential diagnosis frequently can be made thereby.

The results obtained by Herzog are as follows: Of the sixteen patients in the first group, four of whom showed disease of the nasal sinus, nine recovered completely, four recovered partially and three did not show any improvement. Of the thirteen positive cases in the second group, ten recovered completely, one partially and two did not show any improvement.

H. H. Vail, Cincinnati.

Explanation of Accidents in Conduction Anesthesia in the Fossa Pterygopalatina. M. Slobodnik, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**: 187 (Sept. 5) 1928.

The principle of conduction anesthesia of the branches of the trigeminus nerve and that of the gasserion ganglion has been known for a long time. In dentistry, the conduction anesthesia of the mandibular nerve and the so-called tuberanesthesia is used in the direction from the mouth (Fischer). Boenninghaus suggested the injection of the anesthetic with a slightly bent needle high up above the third molar until the tuber maxillare is reached, for the Caldwell-Luc operation. Carrea-Hofer recommended the method through the foramen palatinum majus. Passow and Claus described the use of a straight cannula in the direction from the mouth analogous to the method of Braun in which entry is made behind the zygomatic process with penetration into the fossa pterygopalatine. Ostwald devised another method in the direction from the mouth with a bayonet-shaped needle. Several years ago, the author recommended a bent needle for use in the fossa.

The anatomy of the region is such that a rich venous plexus of varying size and shape is encountered by the needle in the pterygopalatine fossa. This plexus extends from the pterygopalatine fossa to the neck of the ascending branch of the inferior maxilla and to the membranous part of the eustachian tube. A portion of the plexus surrounds the internal maxillary artery. An injury may be dangerous on account of the individual peculiarities of the venous plexus and system of anastomoses (with the veins of the orbit, of the maxillary antrum and of the nose, the vena meningea media, the plexus temporalis medialis, the pharyngeal plexus, etc.). An injury may lead to a hematoma which may suppurate subsequently. In Ullmann's patient, violent pain set in on the right side ten days after the operation. It must be assumed that, through the injection in the direction from the mouth, the vessels were injured, and that a hematoma formed, with subsequent infection and thrombosis of the petrygoid plexus in all directions, toward the maxilla and behind the region of the tonsil. This process extended to the facial veins, the internal and external jugular veins, etc. The second injection, from five to six weeks after the first, may have caused: (1) an injury to a vessel, with formation of a hematoma or (2) infection of the hematoma produced by the first injection which was not yet resorbed or organized. Resorption of a hematoma may take a long time (Leser). In other instances, blood vessels may be injured in an attempt to find the maxillary nerve, which is difficult. Ullmann reported such a case. The author has operated on more than 300 patients, without any accident, using conduction anesthesia of the second branch of the trigeminus nerve (fossa pterygopalatina), with a bent cannula in the direction from the mouth. After a meticulous disinfection of the mucous membrane, the author proceeded with greatest care. He agrees that conduction anesthesia should be confined to cases in which the pterygopalatine fossa is in the operative field and opened; for instance, in resection of the upper maxilla. Frequently, although not always, Fischer is correct in saying that any infection can be attributed to carelessness on the part of the surgeon. Greater care is recommended with various methods of anesthesia, and, if complications arise, interference should not be long delayed.

THE VALUE OF THE DICK SCARLET FEVER INTRACUTANEOUS TEST FOR LARYNGORHINOLOGIC PATIENTS. KARL M. MENZEL, Ztschr. f. Hals-, Nasen- u. Ohrenh. **22**:233 (Nov. 10) 1928.

The Dick test was made on 151 adults who suffered from laryngorhinologic diseases. The scarlet fever toxin of the Vienna serotherapeutic institute did not give a specific intracutaneous reaction. Patients who had had scarlet fever showed the same percentage of positive reactions as those who had not.

2. The assumption was not confirmed that the fact that patients had suffered from angina and peritonsillar abscesses had an influence on the reaction. In the majority of these conditions, the hemolytic streptococcus was found.

3. A former tuberculosis of the lungs did not influence the Dick reaction.

4. The percentage of positive Dick reactions seems to be smaller among patients suffering from peritonsillar abscesses at the time of the test.

5. Frequent repetition of the Dick test on the same person did not show an essential variation in the reaction.

AMBERG, Detroit.

Society Transactions

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Regular Meeting, Oct. 1, 1928

WALTER H. THEOBALD, M.D., *Chairman*

THE EARLY DIAGNOSIS AND TREATMENT FOR LARYNGEAL CANCER. DR. JOHN EDMUND MACKENTY, New York City.

This paper will appear in full in a later issue.

DISCUSSION

DR. JOSEPH BECK: Glick, Sorensen and others in Europe were among the first to recommend laryngectomy, but the results were not good. The operation by Crile was little better. Later came the use of x-rays and radium and the method of burning out the larynx with the Percy cautery; the patients, however, did not improve much more. They lived through the operation and died from cancer as though they had not been operated on. Since the perfection of the technic by Dr. Mackenty, the results are much better. There is a great deal more to be hoped for if the cases are seen early enough. Too many cases are not presented until the glands of the neck are enlarged. As a matter of fact, in cases of this type, operation should not be performed.

One point to be emphasized particularly in the technic employed by Dr. Mackenty is the corking of the trachea by means of a rubber tube. This keeps the secretions from running into the trachea, plugging the bronchi and setting up a septic bronchitis.

In preoperative preparation it is important to see that the patient is a good risk. The anesthetic of choice is a synergistic analgesia. I have not used anesthesia by inhalation. The use of the suction apparatus after the operation, so that the patient will not have to cough, is of great help. Feeding is carried on by means of the Rehfuss tube which the patient carries until the esophagus is healed. There should be nurses for both day and night to watch the patient carefully.

Dr. Mackenty emphasized the harm that comes from treatment with x-rays and radium in these cases.

As to the age of the patient, last year, I showed a patient, aged 29, on whom I had operated for a cancer of the larynx. In a recent report, it was stated that the patient was working and in good condition. He had gained 40 pounds (18.1 Kg.) in weight. I am asked occasionally if it is worth while to operate on a patient aged 60 or 70. If a patient is operated on for carcinoma of the larynx and lives for six, seven or eight years, the operation is worth while.

DR. C. F. YERGER: I cannot agree with the statement that cancer of the larynx offers the most favorable prognosis for cancer in any part of the body. I believe that a better prognosis is offered in cancer of the skin and mucocutaneous regions, such as the lip, especially the basal cell type of epitheliomas; also in carcinoma of the cervix uteri and possibly of the breast. Regions of the body in which the cancer is visible early or those in which there are pronounced early symptoms offer a better prognosis because the patient seeks medical advice earlier.

The reason that cancer of the larynx affords a fairly good prognosis, much better than some of the more deeply-seated organs, is that the growth is usually situated on the vocal cord and produces hoarseness early in the course of the disease, thereby affording an early diagnosis and treatment. Other reasons are the favorable anatomic peculiarities of the larynx which may aid in the resistance to the development of a cancer; namely, the relatively sparse lymphatic circulation

of the larynx, protection by a natural barrier of cartilage, which cancer does not invade as freely as soft tissues, and isolation of the larynx from surrounding structures.

Cancer spreads and metastasizes by way of the lymphatics; hence, in cancer of any organ one must be familiar with its lymphatic circulation. Cuneo has shown that the lymphatics of the larynx may be divided into two groups, those above and those below the glottis. The lymphatics above the glottis empty into a lymphatic gland in the digastic region at the bifurcation of the carotid; the lymphatics below the glottis drain into the deep cervical lymphatic glands along the larynx and trachea, the supraclavicular glands, and eventually they may involve the mediatsinal glands.

I saw a case of carcinoma of the larynx in which the only sign or symptom was an enlarged and hard lymph gland situated in the region of the bifurcation of the carotid. The diagnosis of carcinoma was made by biopsy. Examination of the larynx disclosed a primary carcinoma of the larynx.

I wish to emphasize the necessity of making both a direct and an indirect laryngoscopy, also the difficulty of appraising correctly the extent of the carcinomatous involvement by laryngoscopic means. Exploration at operation generally shows the carcinoma twice as large as the laryngoscopic examination disclosed.

In my opinion there is no endoscopic method of removing a cancer of the larynx completely and securely and that preference therefore should be given to laryngofissure.

Often there is a question as to whether a thyrotomy or a laryngectomy is indicated. This is a most important point to decide. In some of the early cases, it is not necessary to deprive the patient of his larynx. Retention of the larynx, if it does not jeopardize the life of the patient, would be the ideal method. When the cancer is small and can be completely eradicated by excision, thyrotomy should be done. The patient, however, should be carefully watched and examined monthly. If there are evidences of recurrence, a complete laryngectomy should be performed.

I asked Dr. Mackenty if he used Broders' method of classification of the index of malignancy. Broders divides carcinoma into the following four groups depending on the degree of cell differentiation present: group 1, in which the number of tumor cells equals 25 per cent; group 2, 50 per cent; group 3, 75 per cent, and group 4, 100 per cent. If the carcinoma belongs to group 1, and in some cases to group 2, the case is considered suitable for thyrotomy; if to group 3 or 4, a conservative operation is contraindicated, and a total laryngectomy is advisable.

Dr. G. W. Boot: I am glad to hear Dr. Mackenty say that he has found radium of little if any use, because that coincides with my experience. In my opinion, the ordinary patient is much worse off after radium has been used than if it is omitted entirely.

Dr. Mackenty's statement that tuberculosis of the larynx always begins in one particular place is rather surprising. I am sure that I have seen it begin in other places. It is also surprising to hear that cancer also begins in one place only. I have seen it begin simultaneously in wholly separate places. At a previous meeting I described a man with two cancers and four precancerous lesions, probably cancers in reality, all of which started at once. I also examined a man who had cancer, syphilis and tuberculosis of the larynx at the same time. Dr. Beck made the first diagnosis, Dr. Friedberg the second and I the third; a postmortem examination disclosed all three conditions.

Remarkable results have been obtained at the Cook County Hospital with diathermy in cancer of the throat. I consider it an agent that will supersede most of those now being used.

I am interested in the statement of Dr. Mackenty about picking out good operative risks, patients who have syphilis, diabetes, cancer and a few other diseases. I wonder what would constitute a poor risk.

Dr. Alfred Lewy: Much of Dr. Mackenty's success is due to his skill and resourcefulness in combating postoperative sequelae. It would be interesting to secure more details concerning the methods employed by Dr. Mackenty, especially in the cases in which the condition heals slowly.

DR. WALTER H. THEOBALD: What is the relative frequency of carcinoma of the larynx in male and female patients?

DR. JOHN EDMUND MACKENTY: I am not in a position to discuss the two-stage operation referred to by Dr. Beck for the reason that I have never adopted it. My early training in surgery leads me to feel that surgical procedures should be done at one time, if possible.

The highest hope in this work is to treat the patients as early as possible. The earliest cases which I have seen came from South America and Cuba. Spaniards are a hardy race, and I have never had a Spaniard die after laryngectomy. The laryngologists in Cuba and South America seem more alert to the early manifestations of cancer.

I have not had any success with the extrinsic operation. In all cases in which I performed an extensive block operation of the neck, the patient eventually died from cancer. Recently, I had two patients in whom only the top or anterior surface of the epiglottis was involved. The patients are alive, two years and eighteen months, respectively, after operation. Whether there will be a recurrence of the condition cannot yet be determined. If a total laryngectomy is contemplated and a preliminary tracheotomy must be done, it is well to make the opening as high as possible so as to be able to remove the tracheotomy opening with the larynx. One should not go high enough, however, to reach the area of cancer.

Since I have been safeguarding the patient from blood flowing into the trachea and larynx, I have not had a single case of pneumonia. Blood in the lungs at operation is equivalent to a foreign body. It forms a nidus for bacterial activity. Another thing that that has helped is a special method of drainage. It has prevented mediastinitis. The progress made in metabolism has helped tremendously in getting these cases ready. The blood chemistry of the patient should be studied carefully and corrected if faulty. All patients more than 40 years of age should be digitalized. After operation the patient is fed through a tube which is placed into the esophagus about 6 inches below the larynx. The whole operation can be done under local anesthesia if desired, but this causes too severe a shock to the nervous system. The strength of the patient is better conserved by a combined anesthesia (scopolamine $\frac{1}{200}$, morphine $\frac{1}{4}$, regional procaine hydrochloride from 1 to 0.5 per cent and ether). About half of the operation is done under local anesthesia.

There seems to be a specific toxemia with carcinoma. When cancer is removed, the patient takes on a new lease of life. I do not think that carcinoma is ever cured. Like syphilis and tuberculosis, it can be arrested.

Answering Dr. Yerger's question as to early carcinoma in other parts of the body, while I am not acquainted with general surgery, I understand that surgeons are obtaining cures in only 50 per cent of cases of cancer of the breast. The results in cancer of the larynx are better than that. Cancer of the cervix, if seen early and if an extensive operation is done, offers as good or possibly better results. Cancer of the skin does not come under the same category because it is not so malignant. Cancers of the mouth are malignant unless taken early.

The recurrences have been in the neck glands in all the cases which I have seen. The region around the angle of the carotid artery is the most likely to be involved. I have never seen a case of recurrence in the mediastinum. This is probably due to the fact that there is a separate set of lymphatics for the neck and for the mediastinum. So far as I know, these do not intercommunicate.

Dr. Yerger was correct about estimating the amount of cancer in the larynx. It is difficult to tell how large a cancer is by looking at it from above. When the larynx is opened it is usually three times as extensive as it seemed on examination.

When Jackson made the biopsy in one case, cancer was not found. Shortly afterward, the patient developed a fulminating cancer. He had, what is now being more and more recognized as a precancerous condition.

I do not object to doing thyrotomy when it is indicated, although I have not had the glorious results with thyrotomy, reported by the men abroad. There has been a recurrence in 35 per cent of the cases, but I do not get the early cases.

For thyrotomy, the Thompson method is probably the better. Years ago, I did a hemilaryngectomy in several cases, but the mortality was greater than in total extirpation. Thompson's operation lies somewhere between a thyrotomy and a hemilaryngectomy. I remove the thyroid cartilage over the diseased area. This has only one disadvantage; if there is a recurrence it will invade the neck at once because there is no cartilaginous barrier to prevent or retard it.

To a certain extent, I believe in Broder's method of classification. I have seen cases, however, in which it did not hold, and in which the malignant condition was pronounced in spite of the fact that the cells were few in number.

I was glad to hear Dr. Boot's statement about radium. Jackson once believed in radium, but he now feels much as Dr. Boot and I do. Radium is good in certain conditions, such as cancer of the skin, but in this particular condition it is not.

The idea that tuberculosis always occurs in one place was not conveyed intentionally. I was trying to classify the problem of diagnosis. Tuberculosis is liable to invade the posterior part of the larynx. Tuberculosis may begin anywhere in the larynx, as will any tumor. It may begin in the epiglottis and the epiglottic folds, but when it involves the inside of the larynx, it is likely to attack the posterior commissure. Tuberculosis of the larynx does not occur, I believe, unless preceded by tuberculosis of the lung, either latent or active. This fact should be decided by expert examination of the lungs; it is not always found on ordinary examination.

Dr. Lewy asked about the cases which heal slowly. The severe cases are due to radium. It is often impossible in these to effect a closure. The whole wound may fall apart leaving a large dehiscence or only a fistula.

I use a T incision. It is important to get the closure at the angle of the T in order to avoid an open hypopharynx. It may break down on either side and heal up without trouble. If this bridge breaks down, however, a fistula is sure to result and plastic operation will be necessary. A simple closure is made with a mattress suture, which gives a good line of contact. When the wound breaks down, it is necessary to wait until every bit of infection is gone before attempting closure, which can be done under a local anesthetic. The tissues are spilt; the inner flap is inverted with mattress sutures and the outer everted with the same stitch. When suturing is completed, there should be a ridge of tissue on the line of union.

Answering Dr. Theobald's question, it may be said that cancer of the larynx in the female is rare, occurring in not more than 5 or 6 per cent of the cases. Thompson, of London, has observed about the same percentage. Cancer in the female appears to be growing more common. I have seen five cases in the last four years: one in a patient aged 20, two in patients aged 26, one in a patient aged about 30, and one in a woman aged 58. Laryngeal cancer seems to occur at an earlier age in the female than in the male.

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OTOLOGY AND LARYNGOLOGY

Regular Meeting, Dec. 19, 1928

JAMES A. BABBITT, M.D., *Chairman*

THE CEREBRAL-CISTERNAL SPINAL LAVAGE METHOD OF TREATMENT FOR SEPTIC MENINGITIS. THE INTRACAROTID TREATMENT OF EXPERIMENTALLY PRODUCED PNEUMOCOCCUS MENINGITIS. DR. JOHN A. KOLMER.

Septic meningitis refers to that caused by pneumococci or streptococci which usually arises from infection of the middle ear, mastoid or paranasal sinus. One may recover from strictly localized meningitis caused by these organisms, but the

deaths from the diffuse spreading types with purulent cerebrospinal fluids still carry a mortality rate of nearly 100 per cent. Aside from this mortality rate their frequency demands increasing efforts toward the evolvement of more efficient methods of prevention and treatment.

Diagnosis is frequently and indeed usually greatly delayed. In the opinion of Dr. Kolmer, a culture on blood agar or in dextrose hormone broth should be made routinely in every case of mastoiditis at the time of operation, and an exact bacteriologic diagnosis should be demanded. If pneumococci or streptococci are present, a specially careful watch for meningitis should be maintained; if this complication develops, diagnosis is already greatly aided. Furthermore, in pneumococcic infections it is possible that the intramuscular injection of from 25 to 50 cc. of pneumococcic antibody solution or antipneumococcic serum may possess prophylactic power, especially in type I infections, even though the passage of the antibody into the cerebrospinal fluid may not occur and is indeed not to be expected. This would appear to be an acceptable practice in all severe pneumococcic infections of the mastoids at least.

In the experience of Dr. Kolmer, however, carefully conducted spinal puncture and the slow removal of a few cubic centimeters of cerebrospinal fluid for microscopic inspection and laboratory examination have been without discernible harm. It may be that clumsy technic including the use of large needles and the rapid removal of large amounts of fluid may favor the spread of a localized patch of meningitis or the localization of organisms in the blood in the meninges; however, he is reasonably sure that gentle puncture with a needle of from 16 to 19 gage and the slow removal of 5 cc. of fluid, which is ample for all diagnostic tests, has not produced either result. Nor has he been able, in the case of dogs, to localize experimentally pneumococci from the blood into the meninges by simple spinal punctures and the withdrawal of even large amounts of spinal fluid, corresponding to as much as from 1 to 2 cc. per kilogram of weight.

By treating experimentally produced meningitis in a large series of dogs, Dr. Kolmer has definitely demonstrated that the instraspinal injections of various medicaments associated with the intravenous administration of bactericidal substances or of pneumococcic antibody solution will not cure a definitely established septic meningitis of a pneumococcic or a streptococcic type. He believes that generalized pneumococcic and streptococcic meningitis are practically 100 per cent fatal and that unless radical forms of treatment are attempted as early as possible, there is little hope of saving the patient.

He has tried intravenous injections of ethyl hydrocuprein hydrochloride, mercurochrome-220 soluble, sodium-oxymercury, diacetoxymecuri-4-nitro-2-cresol, gentian violet, acriflavine, a flavine dye and Pregl's solution, without the slightest effect; also, intramuscular and intravenous injections of pneumococcic antibody solution and serum and polyvalent antistreptococcic serum were without effect. It may be that these substances are helpful in combating toxemia and bacteremia but are without demonstrable effect on the course and outcome of experimentally produced septic meningitis. He has also used all of them excepting the flavine dye in the treatment for infections in human beings without success.

Dr. Kolmer has used intraspinal injections of ethyl hydrocuprein hydrochloride, mercurochrome-220 soluble, sodium-oxymercury, diacetoxymercuri-4-nitro-2-cresol, gentian violet, acriflavine and a flavine dye, with similar disappointing results in the treatment for experimentally produced infections; also, ethyl hydrocuprein hydrochloride, sodium-oxymercury and gentian violet were used for infections in human beings without results.

With such results and experiences he abandoned all hope of conquering septic meningitis by chemotherapeutic and biologic therapy or a combination of these until such time when more powerful antipneumococcic and antistreptococcic agents in vivo were discovered; he turned hopefully to the subject of surgical drainage as a method of treatment, as Hill, Dandy, Rainey and Aford, Eagleton and others had reported some encouraging results from drainage by laminectomy, cisternal puncture or more radical procedures.

In view of the difficulty and the impossibility of bringing antibacterial agents in contact with all of the meninges infected in severe diffuse meningitis by this quadruple method of injection, especially when the exudates are purulent and plastic, Dr. Kolmer has tried the treatment of pneumococcus meningitis experimentally produced in dogs by the injection of pneumococcidal agents into both common carotid arteries. The injection of gentian violet and other dyes has shown an intense and widely distributed concentration of inoculum in the cerebral and basilar meninges reaching as far as the upper part of the cord as well as the passage of a portion into the cerebrospinal fluid.

About 60 per cent of dogs were cured when treatment was instituted on the onset of signs and symptoms of meningitis following intracisternal injections of virulent type I pneumococci under the following plan:

1. Ether anesthesia.

2. Puncture of the cisterna magna and removal of the purulent fluid; needle left in position.

3. The injection of 1 cc. of pneumococcic antibody solution or antipneumococcic serum with ethyl hydrocuprein hydrochloride (25 cc. of antipneumococcic serum with 1 cc. of 1:100 ethyl hydrocuprein hydrochloride) into each common carotid artery per kilogram of weight.

4. The intracisternal injection of 3 cc. of the mixture per dog (from 3 to 5 kilograms of body weight) followed by the withdrawal of the needle.

So far the method has not been tried in human beings as the laboratory studies up to this point have just been completed; however, Dr. Kolmer thinks it is worthy of trial. It should be emphasized, however, that the treatment was instituted early in the course of the disease only when meningitis was present with cloudy cisternal fluids teeming with cocci.

DISCUSSION

Dr. B. A. Randall: For fifteen years I have advocated lavage of the subarachnoid space, and by so doing have had one or two recoveries from generalized meningitis. It is worthwhile to combine this lavage with saline hypodermoclysis.

Dr. S. MacEwen Smith: I am especially interested in the statement of Dr. Kolmer that spinal puncture, if carefully performed, was not followed by spreading of the meningitis. A spinal puncture is essential for an early diagnosis. Years ago cisternal drainage was advocated by Dr. Haines. I have performed cisternal operations on three patients, all of whom died. I believe that cases of this sort require more than simple drainage.

Dr. George B. Wood: Does drainage of the cisterna bring antibodies into the spinal fluid?

Dr. Kolmer: The drainage alone does not produce results. Perhaps it does influence the passage of antibodies into the subarachnoid space. The best results can be obtained by intracarotid injection combined with cisternal drainage and lavage.

Acute Mastoiditis Accompanied by Lateral Sinus Thrombosis and Multiple Brain Abscess. Dr. John R. Davies.

Dr. Davies reported a case of acute bilateral mastoiditis, sinus thrombosis and multiple brain abscess in a child, aged 2 years. The symptoms of meningeal inflammation were referred to the right ear, which had shown few symptoms, the left one having been operated on for mastoiditis and lateral sinus thrombosis. An extradural abscess had been discovered when an operation was performed on the right mastoid. Repeated examinations of the eye-grounds failed to help in the diagnosis. A pneumococcus was found in the pus of both mastoids and a hemolytic streptococcus in the lateral sinus. Blood cultures and repeated cultures of the spinal fluid were negative. Lateral sinus thrombosis of the left side was demonstrated by the Ayer-Toby test. Autopsy showed a purulent leptomeningitis over the whole brain, with a subdural collection over the right temporosphenoidal lobe. In addition to this, there were multiple subcortical abscesses and pus in each lateral ventricle.

DISCUSSION

DR. MERRITT STILES: Could this serious condition have been avoided by early myringotomy? Would pneumococcic antibody solution have been of value? Were the swellings on the body of the child the result of streptococcic infection?

DR. S. MACEWEN SMITH: To turn out the clot of the thrombosed sinus alone is not sufficient to produce bleeding, and if the clot can be dislodged and good bleeding secured from below and then from above, it may be unnecessary to ligate the jugular. In the average case, however, it is probably better to ligate.

DR. B. A. RANDALL: I have noticed that pneumococcus is almost always present in acute cases. In my opinion, the jugular bulb in children is usually the initial site of thrombosis. In acute cases the phlebitis and thrombosis are largely self-limiting. In chronic cases, pus is almost always formed. The recognition of brain abscess is often difficult, and localizing signs are absent. One of the most valuable symptoms of abscess of the cerebellum is the appearance of atrophic conditions of the lower extremities.

THE NATURE OF NYSTAGMUS AND DIZZINESS OCCURRING IN CERTAIN POSITIONS OF THE HEAD AND IN MOVEMENTS OTHER THAN THOSE AROUND THE LONG AXIS OF THE BODY. DR. JOSEPH C. YASKIN. (By invitation.)

Fifty consecutive cases were investigated in an otologic clinic in Vienna to determine the occurrence of nystagmus and vertigo in certain positions and movements of the head other than those around the long axis of the body. Twelve of the patients had combined nystagmus and vertigo, seven vertigo only and thirty-one gave no response.

An etiologic relationship could not be established between these phenomena and any clinicopathologic condition in our patients. All except one of the ninteen patients had normally irritable labyrinths, ten had cochlear hypofunction and seven had chronic processes of the middle ear, which did not form striking contrast with the thirty-one patients who did not reveal either nystagmus or vertigo.

Our investigations would assign the immediate cause of these phenomena to increased susceptibility of the component of the semicircular canal of the labyrinth. This does not mitigate against the occurrence of these signs in lesions of the brain stem and the parts of the central nervous system as reported in the literature. In these cases, however, there was no evidence of such lesions.

These two signs by themselves are not indicative of a serious condition in either the peripheral ear or the brain stem. In themselves they are not sufficient indications for establishing a diagnosis of a serious condition in either the ear or the brain stem and are not indications for surgical intervention.

DISCUSSION

DR. ROBERT HUNTER: I have found that nystagmus with the head in unusual positions is not uncommon. Some time ago I reported one of these cases as disease of the otolith apparatus. Probably this case was merely one of nystagmus which occurred as a result of a change in the position of the head. I cited the cases of three patients who developed vertigo or nystagmus when the head was placed in certain positions. One improved spontaneously, one after tonsillectomy and the third was not followed. Probably the semicircular canals are closely associated and the action of one affects that of the other.

Directory of Otolaryngologic and Ophthalmologic Societies *

NATIONAL

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President: Major Royal Reynolds, Fitzsimons General Hospital, Aurora.
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Place: Assembly Room of Metropolitan Bldg. Time: First Saturday of each month from October to May.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

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Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month.

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President: Dr. Arthur J. Fort, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. Leon E. Brawner, 157 Forrest Ave. N. E., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. N. E. Time: 8 p. m., last Thursday of each month.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. Edwin McGinnis, 104 S. Michigan Ave., Chicago.
Secretary-Treasurer: Dr. Austin A. Hayden, 25 E. Washington St., Chicago.
Place: Grill Room, Stevens Restaurant, 16 N. Wabash Ave. Time: 6 p. m., first Monday of each month from October to May.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Lafayette Page, Hume-Mansur Bldg., Indianapolis.
Secretary: Dr. Kenneth L. Craft, Hume-Mansur Bldg., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. M. Earle Brown, Maison Blanche Bldg., New Orleans.
Secretary-Treasurer: Dr. W. A. Wagner, Pere Marquette Bldg., New Orleans.
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Secretary-Treasurer: Dr. Charles T. Porter, 520 Commonwealth Ave., Boston.

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Place: 103d St. and 5th Ave. Time: 8:30 p. m., fourth Wednesday of each month from October to May.

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Secretary: Dr. A. L. Stotter, 1148 Euclid Ave., Cleveland.
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Place: College of Physicians. Time: 8:30 p. m., first Tuesday of each month from October to June.

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President: Dr. John H. Foster, 1300 Walker Ave., Houston, Texas.
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Pleace: University Club. Time: 6:30 p. m., third Tuesday of each month.

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